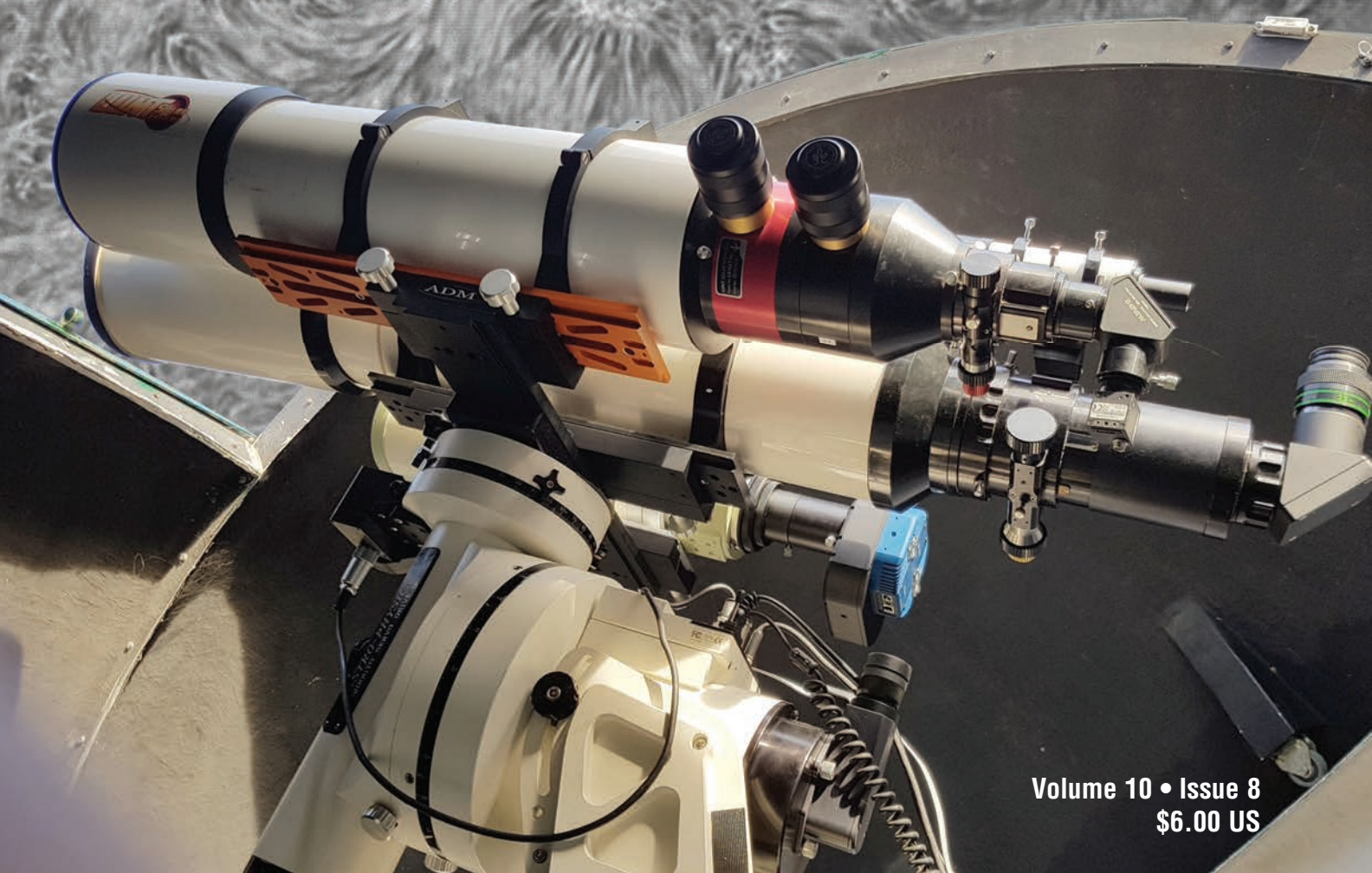
ASTRONOMY TECHNOLOGY TODAY

Your Complete Guide to Astronomical Equipment

LUNT SOLAR SYSTEM LS152 • LUNT SUNOCULERS
ANOTHER TALE OF SAVING ASTRONOMY TECHNOLOGY OF YESTERDAY
PRIMALUCELAB AIRY 100ED • TELESCOPE SUPPORT SYSTEMS

Lunt LS152T Double Stack

Is Double Stacking Worth It?



Volume 10 • Issue 8
$6.00 US

AVALON INSTRUMENTS

STAR·GO

M·UNO FAST REVERSE

I felt it necessary to write this review due of how well this extremely unique product has performed so far and what it has done for both my images, and my enjoyment of astrophotography...

" Over the top ? Perhaps, but it just kinda goes to show the level of detail they have gone through to present their product in the manner they feel it should be. After all, it is Italian "

Tom Bramwell
Transient Astronomers

IC 1396A Elephant Trunk Nebula - 12.5 hours total integration

CLICK ON THE PHOTO TO LINK

ASTROPHOTOGRAPHY MADE SIMPLE !

" I have learned more about astrophotography and improved more in the last few months, than in the first two years before I owned my M-Uno. It has taken all the monotony and troublesome aspects of the hobby and cleared them from my path, allowing me to focus more on improving my data acquisition and post-processing I wish I had known about Avalon sooner "

RELIABLE, OUTSTANDING PERFORMANCES !

*" One major difference I noticed right away between the M-Uno and my previous mounts is how autonomous it is. The M-Uno's on-board computer, the StarGo, is the subtle masterpiece that runs the show. It speaks the very common LX200 protocol, and sits between your PC and the mount. When you command the M-Uno to slew to an object and the motors spring to life, they sing you the most lovely tune as they spin up through their speeds * Guiding at a 2mt focal length, total error usually lives between 0.2" and 0.5" with my crappy, turbulent, light-polluted San Jose skies "*

Even in more turbulent seeing conditions guiding is usually below 1" of total error and I still get perfectly round stars

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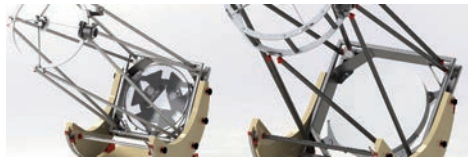
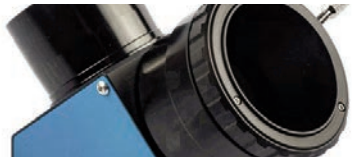
Cover Story: Pages 35-40

Our cover features Phillip Benson's Lunt Solar Systems' LS152THa Hydrogen-alpha solar telescope fitted with a dedicated DSII double-stack module. The background image of the Sun's surface was taken during Phillip's quest to answer the question, "Is double stacking worth it?" Not to give away the ending, but Phillip makes a convincing case for the answer, "Yes, it is."

In This Issue

Industry News/New Products





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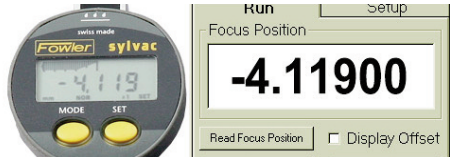

ATT Contributing Writers

Phillip Benson has been a life-long amateur astronomer based in SE England. When he was just a year old, his parents bought a house, which was previously owned by the chairman of the local astronomical society. An IT Technician by profession, Phil now likes to combine his love of astronomy, photography and technology. He specializes in solar imaging and is currently working towards getting a degree in solar astrophysics.

Tore Engen is a Norwegian amateur astronomer who lives in Oslo, Norway. He has been interested in astronomy since the mid-1960s. He is a Unitron aficionado and has taken on the project of saving a 5-inch Unitron telescope he discovered at Oslo's abandoned Sky High observatory.

Dave Komar started the Unitron History Project (http://www.unitronhistory.com/) in 2014 to help chronicle the history of the iconic Unitron telescope brand. As an original owner of two Unitron telescopes, he has been an admirer since first reading about them in Sky and Telescope in the 1950's and decided to take on as a retirement project the research and documentation of the history of the Unitron Company.. His website is intended to serve as a means for sources to provide that information not only on the history, but hopefully on some of the hidden large aperture Unitron and Polarex telescopes.

Gary Parkerson discovered early in his amateur-astronomy career that he was as fascinated by the tools of astronomy as by the amazing celestial objects they reveal – perhaps more so. When not writing about astro-tech, he covers industrial technology for a variety of online resources.

Brian Stephens is an accomplished engineer with vast experience in designing and making narrowband solar telescopes and filters.
Stephen Ramsden (pictured) is the Executive Director and founder of the nation's largest privately funded solar astronomy outreach program-The Charlie Bates Solar Astronomy Project (501c3) - in Atlanta, GA. For further information or to contact Mr. Ramsden please see www.charliebates.org.

Simon Tang was born in London, England, and moved to the US in 2006 to follow a career in TV & Film. He has always had a fascination of space and the sky and decided to take up astronomy. He purchased his first telescope at the beginning of 2016 and since then, has embarked on a journey of exploration all from the comfort of his own backyard.

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AVALON INSTRUMENTS

APM TELESCOPES

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with REAL ED Glass

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ASTRONOMY TECHNOLOGY TODAY

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Editor's Note

Gary Parkerson, Managing Editor

SERENDIPITY AND OTHER HUMAN PHENOMENA

I'm in the Southwestern U.S. as I write this, recovering from the flu. I left Louisiana on May 21, 2016, and have since pedaled the Surly Big more than 4500 miles, sharing telescope views with, and distributing CBSAP solar glass to, thousands of folks in Mississippi, Alabama, Tennessee, Kentucky, Illinois, Missouri, Kansas, Colorado, Oklahoma, Texas, New Mexico, Arizona, California, Nevada and Utah. I biked through a few of those states more than once, as it happened, and of course, I pedaled a bit and shared views this year in my home state of Louisiana, too.

Although I've only been on the road for six months, it feels like forever, which is a tad intimidating, given that it will take another year to finish the 48-state ride. The journey has already been life-changing, as in, I don't feel like the same fellow who pedaled away from home. I hardly recognize myself, at this point, and I suspect there are still major changes in store.

The core goals of the Pedaling Astronomer Project – celebrating the Great American Eclipse of 2017 and spreading the gospel of amateur astronomy – haven't changed, but every other aspect has. Reality is a brutal but effective teacher, and I was not quite prepared for the reality of this solo self-sustained journey.

A young lady recently asked if I ever get tired, and yes, I am thoroughly exhausted when I get off the bike at the end of the day. Ah, but what a wonderfully satisfying exhaustion! I also get quite hungry. In fact, it's hard to find and eat enough food to fuel the miles. I weighed about 145 pounds when I started out, but was down to 129 at a recent point, which is awfully low for an odd old fellow who was once of medium build.

I camp out most clear nights, sometimes at established campgrounds and others wherever I can find a piece of secluded ground. I've learned that this latter approach is called "wild camping," and it often lives up to that label. I stay in cheap motels some nights, but they are always my last resort – their rooms feel awfully cramped after pedaling through endless vistas all day. But my favorite nights are those I spend in the homes of newfound friends, and I've made lots of new friends in the last six months.

If I've made my day-to-day ride experience sound grim, I don't mean to. It certainly doesn't feel that way, and the reasons this has been an overwhelmingly positive journey are the many inspiring people to whom the ride project has introduced me. If there has been a single greatest revelation of this journey, it's how often I'm greeted with, "Are you okay?" followed by some remarkable act of selfless compassion. I don't know whether to be flattered or insulted by that initial reaction – apparently, I appear perfectly wretched after a day's ride – but the resulting generosity will never get old.

Compassion is not the only positive human phenomena I've encountered; there has also been mind-bending serendipity, too. For example, on October 25, 2016, I pedaled out the east gate of Zion National Park, heading for the North Rim of the Grand Canyon, where I planned to camp until November 1, when the park service was scheduled to close access to the North Rim for the winter.

But, I never made it to the North Rim. It turns out, the climb from 4000 to 8500 feet on the overloaded Big was too much in too few days for my aging knees. I was due back in Las Vegas by November 4, so I pedaled back toward the west from Fredonia, Arizona, rather than south to the Grand Canyon, which put me near Pipe Spring National Monument and the Kaibab Paiute reservation on the afternoon of Thursday, the 27th.

The Kaibab Paiutes recently completed a

luxurious but little-used campground there, and I was considering which spot to select when a young lady parked nearby and started hauling telescope gear from her car. I introduced myself, of course – because, telescope! – and she explained that she was a park ranger and the Paiutes were hosting a star party the following night. She was setting up a park-service telescope (a Celestron Advanced VX 8-inch EdgeHD, in case you're wondering) a night early in preparation for the event. I hadn't thought to camp on the reservation for more than one night, but an unexpected star party? Yes, please! I ended up staying three.

And the story of the Kaibab Band's affinity for astronomy doesn't end there. You see, the Kaibab Paiutes have the rare distinction of being the world's first IDA-certified Dark-Sky nation. The International Dark-Sky Association has honored their work to protect the pristine skies of their extensive territory in northern Arizona, and yes, their night skies are gloriously dark!

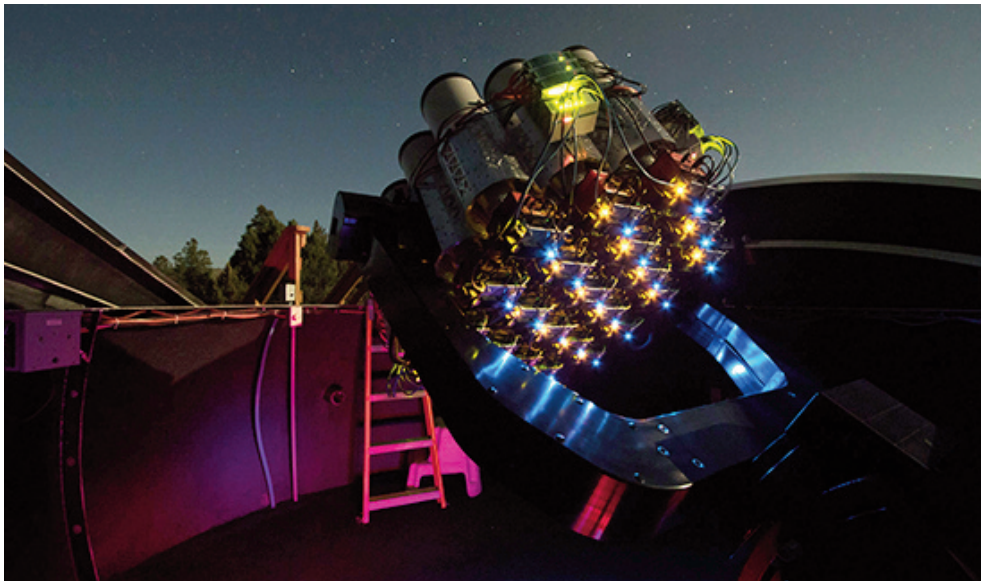
What are the odds of a random pedaling astronomer riding upon a star party at an obscure desert dark-sky site? My head argues they are astronomical; my heart rejoices, "But of course you did!" I'm beginning to understand that such delightful serendipity doesn't occur unless you let it. As a wise fellow recently cautioned, "You're not the boss of your journey," meaning, let it take you where it will lest you spoil it by trying to micromanage every mile. And it's true, I would have missed the Kaibab Paiutes and their exquisitely-dark skies had reality not intervened, and that would have been a shame, indeed. As it is, I will return to visit my new friends among the Kaibab Paiute band, and to enjoy their IDA-certified night skies, again and again.

The Southwest U.S. is heaven on Earth for astronomy enthusiasts, so of course, I love it here. So much so, that I'll wait out the coldest months of winter in its relative warmth, sharing telescope views of the Sun at schools throughout the region, while trying to fatten up a bit before resuming the bike journey in the Florida Keys at the close of the Winter Star Party. From there, I'll continue up the East Coast with the goal of making it to Suffern, New York in time for NEAF 2017, and then it's on to the path of eclipse! The Big and I hope serendipity guides our journey to an intersection with yours somewhere along the remainder of our 48-state journey.

Until that happy day, clear skies! ATT

SOFTWARE BISQUE, SBIG AND CANON

Dragonfly Array Dragon 44 Discovery



It's always fun to see the astro-tech so many of us deploy nightly used in larger contexts, but sometimes those larger contexts are so over-the-top, it takes our collective breaths away, as was the case when we were treated to first reports of the Dragon 44 discovery of the Dragonfly Array.

The Dragonfly Array? Its latest configuration is simply 48 off-the-shelf Canon 400-mm lenses backed by an equal number of SBIG's venerable STT-8300Ms, all carried on two Software Bisque's new Paramount Taurus telescope mounts. That's all.

The Canon lenses feature new nano-fabricated coatings with sub-wavelength structure on the optical glass, which has unprecedented performance in reducing stray light and reflections.

The purpose of the Dragonfly Array is to search out ultra-low contrast objects, which have been overlooked by more conventional instrumentation. Recently, the discovery of Dragonfly 44 was reported, a galaxy that is calculated to be 99.99-percent dark matter. This discovery opens an important new window on dark matter, and has significant implications for theorists seeking to understand Cold Dark Matter cosmology and how galaxies were assembled following the Big Bang.

The Dragonfly Array began imaging targets in 2013 from its home at the New Mexico Skies hosting facility with more modest 12-cameras-per-mount arrays. Images from its latest and grandest configurations have shown that Dragonfly is now at least ten times more efficient than its nearest rival and will be able to detect faint structures predicted by current merger models.

We are so fully immersed in all of this wonderful digital astro tech that it's easy to forget that we're living in the golden age of amateur astronomy … and that things are only getting better. We've enjoyed digital imaging and fully automated mounts for long enough that many of us have forgotten just how powerful all that remarkably affordable off-the-shelf hardware truly is. So yes, it's fun to see the occasional reminder like the apply named Dragonfly Array.

For more information, please visit http://www.bisque.com/sc/blogs/daniel_bisques_blog/archive/2016/08/29/dragonfly-44.aspx and https://diffractionlimited.com/dragon-44-discovery/ .

Image by Christian Garcia

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You can then bring colour to your images by using red, green and blue filters to capture different wavelengths of light. You also open up the possibility of using narrowband filters to go beyond the visible spectrum and capture signals from objects often invisible when using RGB alone, or when imaging from light polluted towns.

The Atik One simplifies the complexity of the equipment needed for this kind of deep sky astrophotography, while maintaining the flexibility to optimise your set-up to your sky conditions and the types of object you like to image. It combines an exceptionally sensitive Sony CCD sensor with an integrated 5-position filter wheel, which can all be controlled through our powerful and intuitive software applications.

A choice of either a 6 or a 9 megapixel sensor lets you pick the One that best suits your telescope. The One 6.0 sensor sets the standard for sensitivity and versatility, while the One 9.0 provides a higher resolution option for those working at short- to mid-range focal lengths. They both pair incredible quantum efficiency with low read noise, to help you capture the faint details that lead to stunning images.

The Atik One conforms to the same high standards demanded in our scientific camera platforms and boasts the same industrial reliability. A cooling delta of 38 degrees below ambient temperature provides consistent, high-performance cooling whatever the weather, and argon purging of the CCD chamber ensures your sensor remains condensation-free.

Best of all, you can choose the Atik One as an Integrated Kit, complete with its own dedicated off-axis guider and Atik GP guide camera. The OAG features our renowned smooth focusing system and moveable prism, which takes the hassle out of finding and focusing your guide star.

All of this is connected through the camera's internal USB hub and accessory power port, giving you everything you need to take long exposure photographs of the deep sky, all in the One.

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GREAT SOLAR ECLIPSE OF 2017

Resources for The Big Event

Excitement continues to build for the Great Solar Eclipse of 2017, which will be visible across the United States on August 21, 2017. Each month leading up to the event, we will cover news centered around what is shaping to be one of the most well published and viewed astronomical events since Haley's Comet.

Peddling Astronomer

As you have read in past issues, this spring, *ATT* Editor Gary Parkerson embarked on a bicycle trip across the U.S. to help promote the hobby of amateur astronomy as well as the feasibility of biking as a viable transportation option. He also has been working with the Charlie Bates Solar Astronomy Project and others to create awareness of how to safely view the upcoming solar event and is giving away thousands of free solar glasses during his travels to the communities he visits, compliments of CBSAP.

Publicity in towns on the route has been exceptional, primarily due to the support and efforts of the Sky-Watcher USA team, who are providing advanced notice to media outlets along the way, as well as funding and equipment to help underwrite the costs of the tour.

So far, Gary has pedaled more than 4500 miles through 16 states. This year's portion of the ride project is concluding in Utah, and next year the ride will kick off in February at the Winter Star Party in the Florida Keys. We'll be providing more details here soon, and you can read regular updates at www.pedalingastronomer.com.

EclipseWatch

EclipseWatch is Celestron's full-featured Eclipse 2017 portal offering news, events, audio/visual content, tips, and everything you will need for the viewing experience of a lifetime.

Of course, you will find everything you would expect, including educational resources, tutorials on how to safely view a solar eclipse and much more. You'll also find more off-the-beaten-path content. For example, there is a description of the August 9, 1896, total solar eclipse as seen by writer Mabel Loomis Todd, who was part of a scientific expedition that traveled to Japan to observe the event. As the Celestron team notes, "Her wording is florid, but you'll never hear anything that delivers the emotions felt during an eclipse like this."

You'll also find a calendar that contains the date and the year(s) of any total or hybrid solar eclipse that has occurred from the year 1 through the Great 2017 Solar Eclipse. How cool is that?

By the way, the Celestron team will be attending eclipse related events, including the Music City Solar Eclipse located in Nashville, Tennessee. As an official sponsor of the event, Celestron joins the Nashville Adventure Science Center for a three day, family friendly science festival at multiple locations throughout downtown Nashville and along the riverfront. The festival will feature live music, daily and nightly star parties with big screen projections of the Sun and planets, workshops, and prizes.

The team will also be represented at the epicenter of the eclipse at the Astronomy League's ASTROCON 2017 in Casper, Wyoming. As a platinum level sponsor, Celestron will be hosting safe Solar viewing as the Astronomical League will hold its annual national convention in the days leading up to the event.

You can find it all at www.celestron.com/2017-eclipse-watch .

National Eclipse

Another full-featured site, the National Eclipse website offers a wealth of information including an outline of some of the unique features, landmarks, and viewing options for each of the fourteen U.S. states located within the path of totality. The site takes potential weather for these sites into consideration, which will be a definite wildcard for viewing the eclipse. The site also offers an interactive map – just hover your mouse over the map to receive specific information on the area.

Another nice aspect of the website is the extensive list of events scheduled along the eclipse's path. Earlier, we mentioned two events the Celestron team will be attending, and you can expect hundreds of events of all sizes associated with the Great Solar Eclipse 2017.

Like wine? Willamette Valley Vineyards in Turner, Oregon, is planning an eclipse viewing party with wine tasting, live music, cellar and vineyard tours, lawn games, and Pacific Northwest cuisine. Into baseball? Keizer, Oregan's minor league baseball team, the Salem-Keizer Volcanoes, will host a three-game brewfest culminating in a morning game that will feature the first ever "eclipse delay" in baseball history.

If you like to wager, The Wind River Hotel & Casino on the Wind River Indian Reservation in Wyoming is inviting visitors to enjoy their casino gaming experience as well as a cultural experience featuring native Arapaho music, dance, and storytelling, eclipse presentations, and star parties. The cowboy in you will enjoy Tryon, Nebraska's "western adventure" for eclipse viewers including a petting zoo, vendors, live music, wagon rides, ranch tours, and an official viewing site.

You can check it all out at www.nationaleclipse.com.

NASA uses Starizona's HyperStar to image Earth from space

Mulanje Massif
in Malawi

HyperStar C9.25 with Canon EOS 7D
digital SLR camera
Image courtesy NASA

You can use HyperStar to image space from Earth

Lagoon and Trifid Nebulae
in Sagittarius

Mosaic with HyperStar C11 and Atik 490EX
one-shot-color CCD camera
Image courtesy Curt Hughes

For capturing images from the International Space Station, NASA chose Starizona's HyperStar system because it provides high-resolution images with very short exposure times necessary to freeze the motion of the ISS at 17,500 mph. The same features make HyperStar the easiest way to capture deep-sky objects right from your own backyard.

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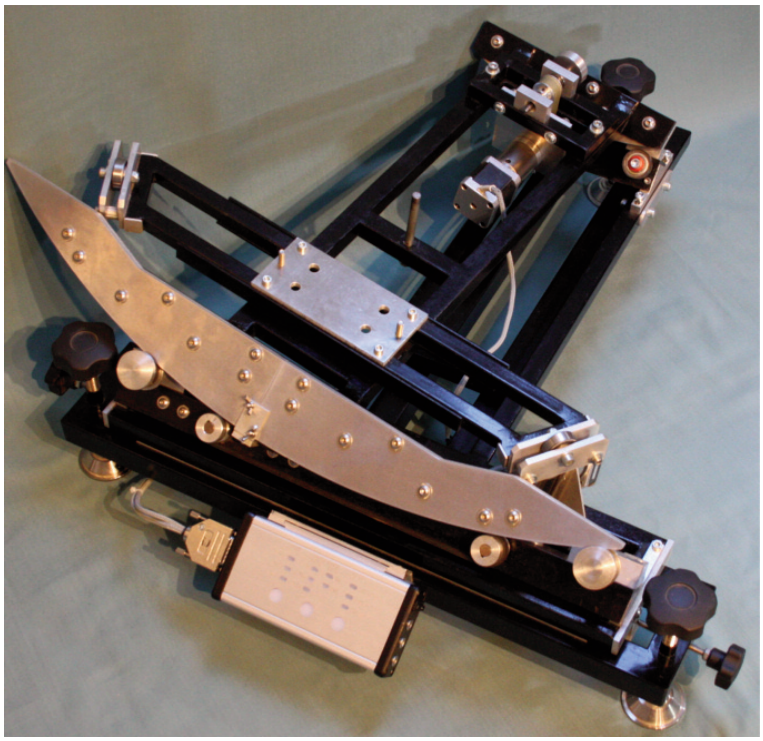

Deep-Astro Instruments had a couple of seemingly mundane goals in mind when designing its new line of Dobs: They had to be easy to transport and to set up, plus they needed to be accurate and robust. The resulting telescopes, though, are, as you shall see, far from mundane. Indeed, their simplicity appears uniquely beautiful to our eyes, as well as functional, portable and durable.

The main structures are constructed of welded steel coated with epoxy paint for ultimate protection against corrosion. All aluminum components are formed to high precision on a digital milling machine and receive an anodized finish.

Because motorized slewing and tracking is integrated into the design, not added on to an existing design, the final form is especially clean and minimalist. The drive system provides three tracking speeds, sidereal, lunar and solar, and for three self-tracking speeds, 0.1x, 0.75x and 0.5x.

Birch Plywood is deployed where wood serves best, and its natural finish compliments the metal components perfectly. The wood components are digitally cut, then finished with a marine varnish.

All aluminum parts are anodized with complimenting colors to enhance the beauty of the telescopes, and all fasteners are of stainless steel.

Each 18-point primary-mirror cell is optimized to the desired deformation profile and defined by the nature and thickness of the specific primary mirror which it will support. Collimation of the primary is performed remotely by two stepper motors with a resolution of 1/10000 turn of the screw, or 0.10 µm. Ventilation of the primary mirror is enhanced by three 80-mm fans for quick cool down.

The secondary mirror is easily secured and locked with a single screw. It is collimated by three easy-access screws.

Adding one of Deep-Astro's equatorial platforms converts the classic Dob into an astrophotography ready instrument that offers the performance of traditional equatorial mounts.

The new Deep-Astro Dobsonians are available in apertures ranging from 300 mm to 800 mm, with pricing starting at 4800€.

For more information, please visit www.deep-astro.com.

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APM TELESCOPES

Adds 2-inch Star Diagonal with 99-percent Dielectric Coatings with Fast-Lock

APM's new 99-precent reflectivity dielectric coated 2-inch star diagonal delivers maximum precision, as well as brightness. The foundation of that precision is its precisely CNC-milled body, but accuracy doesn't end there. The diagonal also integrates APM's Fast-Lock system, a centering clamp that ensures all 2-inch accessories are aligned exactly to the optical access.

The diagonal weighs 560 grams (19.7 ounces) and has an optical length of 125 mm, as well as an unobstructed diameter of 43 mm. Its export price is 121EUR, or 145EUR including VAT.

For more information, please visit their website at www.apm-telescopes.de.

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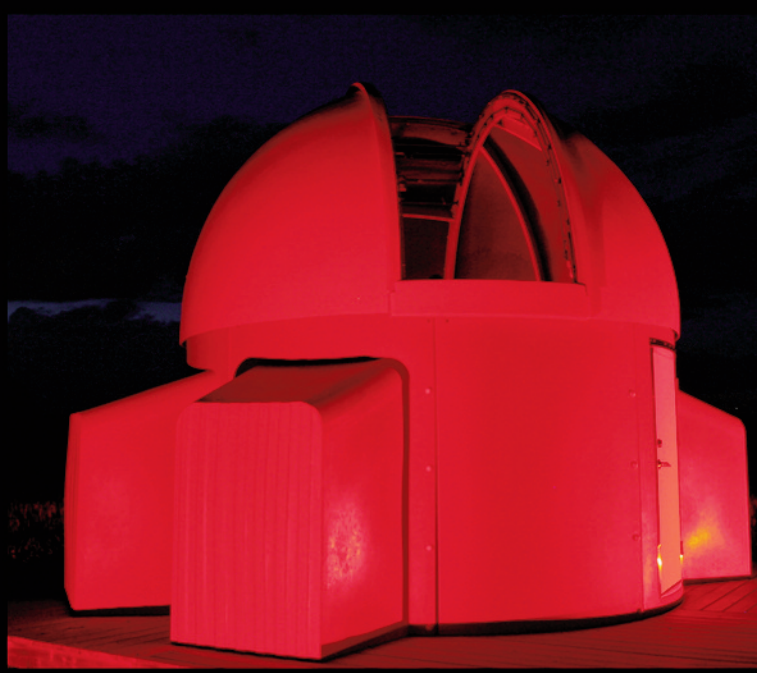

Sky Shed
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AMERICAN ASTRONOMICAL SOCIETY AND EXPLORE SCIENTIFIC

2016 WorldWide Telescope Competition

AMERICAN ASTRONOMICAL SOCIETY

Enhancing and sharing humanity's scientific understanding of the universe since 1899.

EXPLORE SCIENTIFIC

The American Astronomical Society has announced a competition to create the best visual experiences using the American Astronomical Society's WorldWide Telescope (AAS-WWT) system. If you are an experienced WWT user and have made a cool tour, interactive or video in the past, enter the contest. If you are new to WWT but have an astronomy story to tell, jump into WWT and make a tour to submit. The competition is open to everyone; there are no age or nationality restrictions. Just fill out the entry form at: http://wwtworkshops.org/ . Submissions can be made in any of three categories: Research, Education or Planetarium.

Entries in any category can come in any of the following three formats:

(1) WWT Tour (wtt files). These files can be created with the Web Client (http://www.worldwidetelescope.org/webclient/) on any modern machine (less than 3 years old). WWT Tours can also be created using the Windows Desktop Client (http://www.worldwidetelescope.org/Download/) which requires a modern Windows machine to run.

(2) Embedded WWT Interactive. You can use the web controls to create a custom interactive for your website. An example interactive can be experienced here: http://planck.ipac.caltech.edu/wwt/.

(3) Video. You can render out frames from WWT and compose them (potentially combining with another video asset) to create a video file. For videos, AAS requires a link a streaming version (e.g., YouTube).

The WWT website contains comprehensive documentation on making WWT Tours, making videos and embedding web controls.

There will be a first, second and third place prize in each category donated by the American Astronomical Society and Explore Scientific. Details on the prizes will be announced soon.

For more information, visit http://www.worldwidetelescope.org/news.

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TELE VUE

Digiscoping Adapters, Digital Indicator Kits and More

While Tele Vue may be best known for creating state-of-the-art eyepieces and high-end telescopes, the company also offers a number accessories for observing and imaging. Recent additions to the company's lineup include two types of Digiscoping adapters and Digital Indicator kits.

Digiscoping

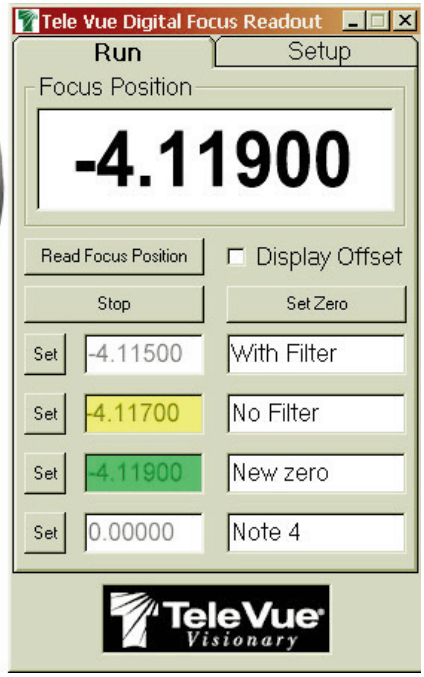
Taking photos through a telescope eyepiece is an easy way to step into nature and planetary/solar photography. Tele Vue has two types of Digiscoping adapters: FoneMate, for smart phones (**Image 1**), and a Digital Rings/Radian Adapter system (**Image 2**), for point-and-shoot cameras with filter threads.

Image 1

Image 2

Tele Vue adapters allow solid, accurate attachment of smart phones and digital cameras to appropriate Tele Vue eyepieces for "afocal" imaging (Digiscoping). "Afocal" means collimating light between the telescope eyepiece and camera lens. To minimize vignetting and maximize image quality, Tele Vue offers an eyepiece specifications table for eyepieces recommended for Digiscoping. As noted in the table, some eyepieces require an additional adapter.

Image 3



Digital Indicator and TVFocus Software

Tele Vue's Digital Indicators employ *TVFocus* software and a special RS232cable to monitor a telescope's focus position on a Windows PC (**Image 3**). *TVFocus* features include: continuous or momentary position readout; up to four preset positions – saved between sessions (this feature is handy when swapping filters that change the point of best focus or when using non-parfocal eyepieces); yellow and green indicators when approaching or have achieved a preset focus position; and zero reset provides the ability to zero the indicator at any point.

The evolution of eyepiece developments at Tele Vue

Many of you may remember the commercial in the 70s and 80s that had the tagline: "When EF Hutton talks, people listen." In the astronomy-products industry the same could be said for Al Nagler. This is true for the editorial staff of *ATT* who take advantage of every chance to sit and visit with Al.

So, when we learned Al posted a guest blog on the *Astronomy* magazine website providing an in-depth overview about the evolution of eyepiece developments at Tele Vue, we were on it! It's a fascinating look into how Al approached eyepiece design over the years. You can view it directly here: http://cs.astronomy.com/asy/b/ astronomy/archive/2015/10/13/the-evolution-of-eyepiece-developments-at-tele-vue.aspx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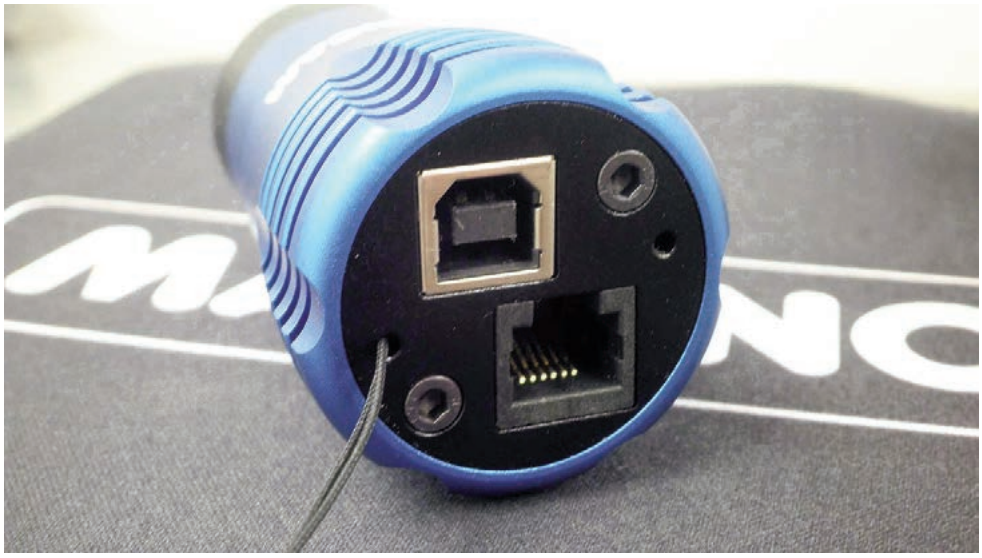
MALLINCAM

Introduces New Cameras

SkyRaider AG1.2c Imager-Guider

MallinCam's new AG1.2c is an inexpensive USB 2.0 camera that can be used as an autoguider, but is also a very capable entry-level camera for those interested in exploring video astronomy. Bottom line, the AG1.2c is the most affordable camera in its class ever offered by MallinCam.



The AG1.2c deploys a carefully selected, passively cooled 1.2 MP, 1/3-inch (6-mm) Sony IMX224 CMOS sensor with a sensitivity of 2350 mv. Pixel size is 3.75 by 3.75 µm and sensor resolutions are 1280 by 960 or 640 by 480.

The sensor is protected by a sealed window with full antireflection coatings on both sides, and the camera is housed in a CNC-machined aluminum case for durability. The AG1.2c weighs just 2.2 ounces (65 grams) and measures 2.5 inches (63.5 mm) in length.

The camera includes a 1.25-inch threaded adapter, an ST4 guiding cable and a 15-foot (5.0-meter) USB cable.

Other features and specifications include: Live stacking on the fly; live star registration, ideal for all motorized alt/az-mounted telescopes; exposure up to 16 minutes; dedicated astrophotography software to support live video, imaging, image stacking, and more; MallinCam's unique dark-field correction (no Peltier cooler needed); and a built-in ST4 auto-guider port.

MallinCam's new AG1.2c is priced at $249.99US.

For more information, visit http://www.mallincam.net/skyraider-ag12c.html .

SkyRaider DS16C Video/Imager/Autoguider

MallinCam's new large-sensor DS16C video/imager/autoguider is the newest in its SkyRaider family of astro-video cameras. The DS16C incorporates a 16.3 megapixel, grade-1 ceramic sensor to deliver the increased sensitivity needed for astronomical observations and imaging – it excels at excelling at live observing of deep sky, filtered solar and lunar objects.

The MallinCam SkyRaider DS16C is the most versatile video/imaging camera ever created by MallinCam for computer use. All astronomical targets can be observed live, while simultaneously capturing images or while video is recorded, making this newest MallinCam a most versatile observing device.

The new sensor measures 22 mm diagonally and delivers high-resolution images with all telescope types. An optional 0.5X, 2.0-inch focal reducer is

also available to further increase the field of view needed for those spectacularly large astronomical objects. The new sensor has significantly improved sensitivity in the near-infrared light region and utilizes square 3.80 µm unit pixels with high signal-to-noise ratio.

The MallinCam SkyRaider DS16C uses USB 3.0 technology (reverse compatible to USB2.0) to deliver fast download speeds, near instantaneous to the computer and perfect for displaying live images, capturing long-exposure images or recording video files. A fan assisted passive cooling system ensures sensor temperature stability and super low noise ratio.

The new MallinCam Skyraider DS16C camera's Panasonic sensor sensitivity is augmented by incorporating CDS (correlated double sampling) procedures. This feature ensures that the SkyRaider DS16C is perfect for astronomy and other dark-field applications, as well as for bright-field applications required for lunar, and filtered solar observing.

By utilizing the *MallinCamSky* software application dark-frame correction feature, an internal Peltier cooler (TEC) is not needed. This results in the use of only a single cable from the camera to the computer's USB 3.0 port. The dark-field correction feature removes all hot pixels, warm pixels, amp glow and most dark current noise on the fly making this premier astronomy camera the idea choice in the field or in an observatory. The dark-field correction technology has been implemented by MallinCam for all SkyRaider Series of cameras, eliminating the need of a Peltier cooler.

Features and specifications include: Live Stacking on the fly; live star registration, ideal for all motorized alt-az mounted telescopes; support and includes full trigger mode; built-in memories; CDS (Correlated Double Sampling); 4656 X 3518 effective pixels; all-pixel scan transfer method; progressive scan; full HD support; hand-selected class-1 sensor (scientific grade); sealed, multi-coated (no-IR) optical window, 3.80 by 3.80 µm square pixels; sensor gain variable to 20x; binning resolutions of 4640x3506, 2304x1750 and 1536x1168; sensor size of 4/3-inch (17.6472x13.3228 mm); 4K2K support; full scan, any size cropping; 4.3 aspect ratio; standard ST4 guiding protocol; all-aluminum construction, precision CNC machining; and hand-crafted electronics assembly. The camera assembly weighs 430 grams (15.16 ounces) and measures 3.1 inches in diameter by 3.25 inches long (78.74 by 82.55 mm).

The DS16C includes a 1.25-inch adapter and a 2-inch adapter one 5-meter (15.5-feet) high-grade USB 3.0 cable, and MallinCamSky software. It is priced at $1399.99US.

For more information, visit http://www.mallincam.net/skyraider-ds16c.html .

Orion Telescopes & Binoculars

Introduces 30-mm Ultra-Mini Guide Scope and FunScope Astro Dazzle Reflector Telescope

30mm Ultra-Mini Guide Scope

The extremely compact 30-mm Ultra-Mini Guide Scope was created by Orion to take advantage of smaller auto-guiding cameras to reduce the total weight of imaging setups. This diminutive guide scope weighs in at just 7.6 ounces (215 grams) and is a perfect match for short focal-length, optically fast imaging telescopes. It offers multi-coated, f/4.3 optics that provide a wide field of view to offer plenty of options when selecting guide stars.

Designed specifically for use with the Orion Star Shoot Auto Guider Pro Mono Astrophotography Camera, the Orion Star Shoot All-In-One Astrophotography Camera, and similar eyepiece-sized auto guider cameras, the Orion 30-mm Ultra-Mini Guide Scope features C/CS-mount threads for flexure-free camera attachment.

The front housing of the guide scope doubles as a precise helical focuser with etched hash-mark scale for easy and repeatable focusing. After an initial helical focus adjustment to match your auto-guider device, a thumbscrew allows the focus position to be locked. If you wish to change autoguider devices, simply loosen the thumbscrew lock and adjust focus to match your preferred device.

A two-ring bracket with a dovetail foot is included which is designed to fit the dovetail base found on Orion telescopes and many other brands. A threaded 1/4"-20 socket on the underside of the dovetail foot allows direct attachment to a universal plate. At just 4.7-inches (119-mm) long, the scope won't take up a lot of space in storage and transport. A die-cut foam lined tin case is included to store the scope when not in use.

The Orion 30-mm Ultra-Mini Guide Scope is priced at $139.99US, including the dual-ring bracket and CS-to-C mount adapter ring. More information is available at www.telescope.com.

FunScope Astro Dazzle Reflector Telescope

The holidays provide the perfect time to help introduce astronomy to a new generation of enthusiasts. Orion has introduced the easy-to-use and family-friendly FunScope Astro Dazzle 4.5-inch (118-mm) Reflector that offers nice entry-level views in a portable, fun package.

Visually, the scope features a uniquely decorated, rolled steel telescope tube adorned with an Orion-designed, exclusive collage of actual celestial photographs of some of the most famous objects in space.

As a visual telescope, it offers good performance for all-around observing of the night sky. It offers a compact design and light weight of just 10.9 pounds, making it easy to transport, while its swivel-base can be set on the ground, on a picnic table, or other similar surface for comfortable use. The base's simple up/down, left/right altazimuth motion makes it easy to point the telescope, and to slowly track celestial objects as they appear to move across the sky.

Included are two 1.25-inch Kellner telescope eyepieces, a 1.25-inch rack-and-pinion focuser, Orion EZ Finder II red-dot sight and a quick-collimation cap.

Also included is the Orion MoonMap 260 which identifies over 260 lunar features including craters, valleys, ancient lava flows, mountain ranges, all successful US and Soviet lunar mission landing sites. It is laminated for protection against dew, dirt, and the elements and measures 25.25 inches by 11 inches when fully unfolded, folding up to 8.5 inches by 11 inches for easy portability. It includes both correct-image and reversed "mirror image" maps of the Moon for easy use with binoculars, unaided eyes, or any telescope.

The scope also comes with a free download of Orion's *Starry Night Special Edition* software. The FunScope Astro Dazzle Reflector is priced at $179.99US.

More information is available at www.telescope.com.

AVALON INSTRUMENTS

Expanded Dealer Network includes ASTC in the Middle East and North Africa

Italy-based Avalon Instruments has announced the addition of three new international dealers, including Astronomical Solutions, headquartered on the Arabian Peninsula, Le clef des Étoiles in France, and Telescopiomania, located in Spain.

Astronomical Solutions (ASTC) is now the sole distributor for Avalon Instruments mounts and other equipment for the Middle East and North Africa region. The company celebrated its grand opening earlier this year and offers amateur astronomers in the region access to a distributor that can cater for their unique needs, including access to Arabic language documentation and to Arabic-speaking sales support and purchase advice. More information is available at www.astronomicalsolutions.com.

Le clef des Étoiles is located in the heart of Toulouse, France, which is considered the European capital for a number of aerospace activities and a Mecca for French history of astronomy. Telescopiomania is the largest online shop in Spain and is located in Barcelona.

You can see the full dealer list at www.avalon-instruments.com/dealers.

VIXEN OPTICS

Replica of Isaac Newton's Original Reflector Telescope

Available now for the holiday season, Vixen Optics' Isaac Newton's famous reflecting telescope offers a sensational instrument recreated by Vixen for those who appreciate history. It is a fully operational handmade telescope that duplicates Newton's telescope on the outside, while having superior, modern optics on the inside.

The 17th century telescope replica has a 70-mm compact size durable aluminum alloy optical tube. Vixen Optics incorporates high-quality mirror technology in conjunction with two 1.25-inch eyepieces capable of producing bright and crisp images of the moon and the planets. The complete package includes a pure ash wood globe pedestal mount and is wrapped in waxed parchment paper enclosed in an antique cargo box as if it really were from Newton's time.

You can read more about the limited edition telescope at their website, www.vixenoptics.com.

SIMULATION CURRICULUM

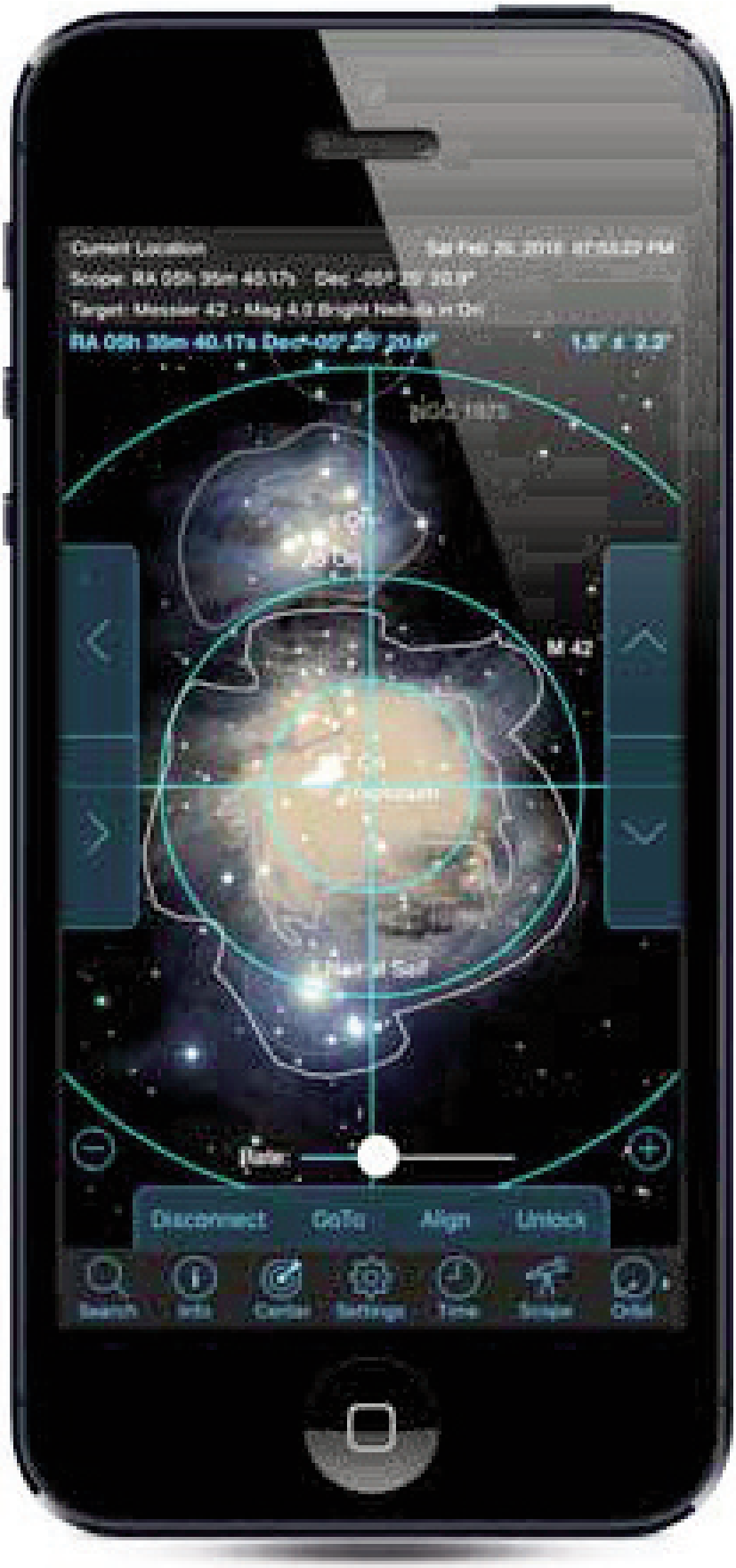
SkySafari 5 Updates

SkySafari has reached version 5 of its astronomy app offered as *Standard* ($2.99), *Plus* ($14.99) and *Pro* ($39.99) versions for iOS, Android and Mac OS. The *Standard* version offers a number of essential features, and with *SkySafari 5 Plus and SkySafari 5 Pro*, users receive telescope control, a bigger database, and even more features.

SkySafari 5 offers 119,000 stars, 220 of the best-known star clusters, nebulae, and galaxies in the sky. It also includes all of the Solar System's major planets and moons, and more than 500 asteroids, comets, and satellites. *SkySafari 5 Plus* moves up to 2.6 million stars, and 31,000 deep-sky objects, including the entire NGC/IC catalog, and 18,000 asteroids, comets, and satellites with updatable orbits. Users get mobile telescope control with the Plus version as well. *SkySafari 5 Pro* tops out at more than 27 million stars, 740,000 galaxies down to 18th magnitude, and 620,000 solar system objects – including every comet and asteroid ever discovered – as well as mobile telescope control.

All versions have seen a complete rewrite, including an updated "Tonight at a Glance" feature, which offers the location and rise/set times of the Sun, Moon, Planets, and International Space Station in one handy view. A new Share button lets you share your sky by email, text, or social media. There are completely new sound effects, and a new look to the sky and horizon including a brighter, more visible Moon. In relation to the iOS version, *SkySafari* now offers complete support for iOS 9 as well as support for Apple Watch.

You can download the app at the appropriate app store for your device and learn more at their website, www.skysafariastronomy.com.



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AZ Mount Pro™

- Low-power-consumption stepper motors operate at whisper-quiet levels
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- Recalls pointing position following power failure
- Built-in WIFI allows complete control with *iOptron Commander*™ and *Sky Safari*™ apps
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Introducing the capable new SkyTracker™ Pro for astroscapes

The SkyTracker Pro is designed for photographers seeking to bring their astroscape imaging to the next level. It offers unique features in a compact, rugged, user-friendly design. The polar finder scope has a a variable brightness illuminated reticle that, combined with fine-tuning controls on the alt-azimuth base, make set up and alignment a breeze. Pointing and framing the camera are now assisted by a bidirectional quick slew control. A stable precise movement with 4 tracking rates (1x, 1/2x, lunar, solar) and a built-in rechargeable power source offering 24 hours of continuous operation round off some of the exciting new features. The SkyTracker Pro, available online or at iOptron dealers worldwide.

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Clear Sky Lab

Announces AstroPiBox

AstroPiBox

Clear Sky Lab's proposed AstroPiBox, a French-language autonomous autoguiding platform, is based upon the Raspberry Pi Linux platform and leverages the Raspberry Pi for autoguiding offering several distinct advantages: **(1)** Power consumption of only a few watts, which makes it possible to use a portable power supply (5-volt) for hours of continuous field operation; **(2)** the Linux operating system provides a stable and reliable platform, allowing access to the entire open-source Raspberry Pi ecosystem; and **(3)** Raspberry Pi is an inexpensive hardware platform that yields quality products at a reasonable price.

The interface of AstroPiBox has been designed with a focus on maximum simplicity – it's easy to launch the various applications installed on the platform, as well as to access its built-in functions.

AstroPiBox is a portable platform for astrophotography whose primary objective is to provide a reliable, easy-to-use, high-quality autoguiding service, but it also includes software and utilities to facilitate both field- and observatory-based astronomy, including cartography software and telescope control, image acquisition, astrometric resolution and simulation of light pollution.

Autonomous Autoguiding

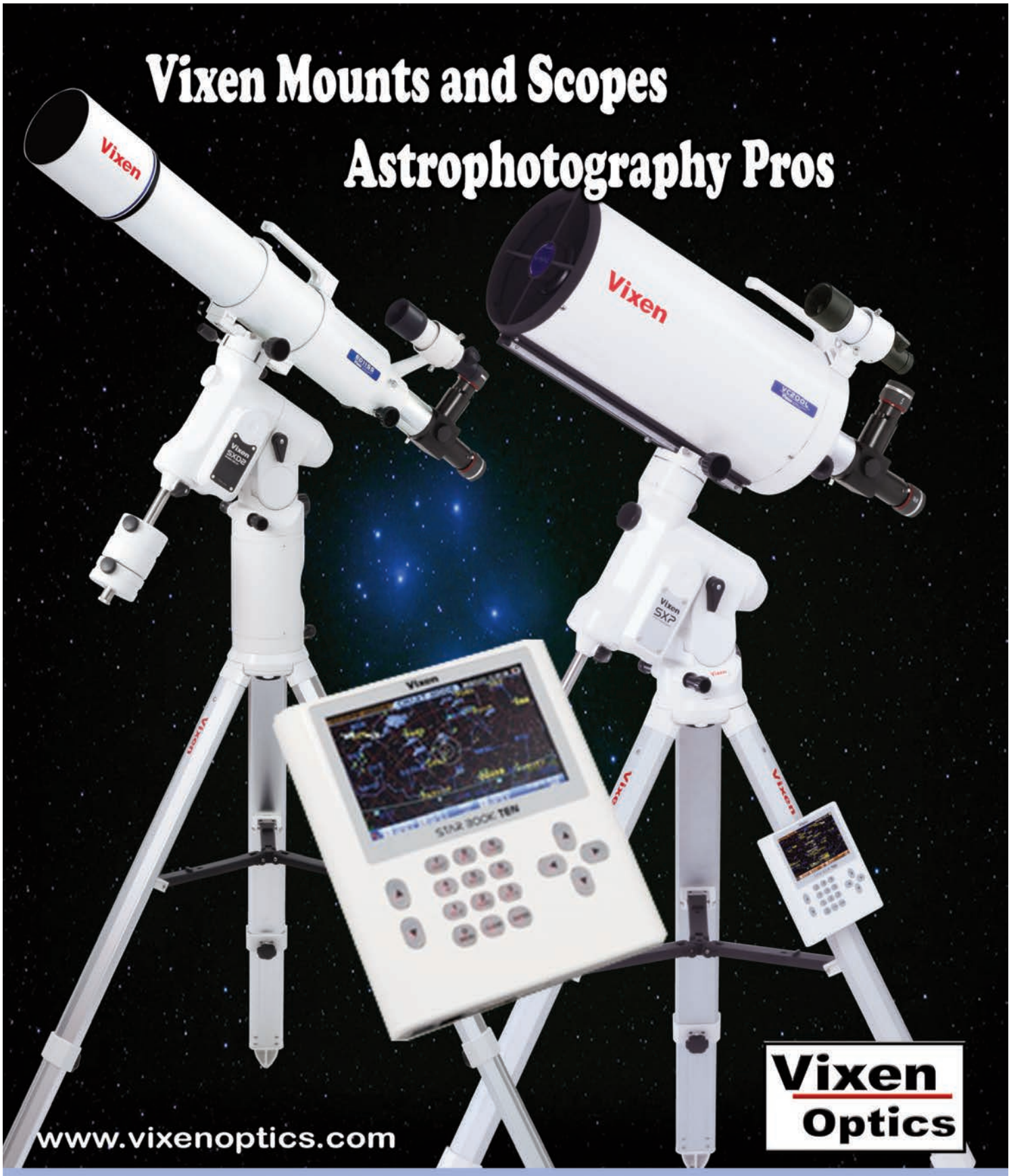
AstroPiBox integrates *PHD2*, an open-source software for autoguiding. *PHD2* was modified by Clear Sky Lab to run optimally on the Raspberry Pi platform and on a 7-inch touchscreen. All necessary libraries were preinstalled in the AstroPiBox Linux environment to enable direct and simple use of *PHD2*, and the French translation has been completed and improved.

Tested with several different frames and cameras, it can be used directly in most configurations in plug-n-play mode without the user having to adjust any parameters whatsoever. This makes it extremely easy to use, while still benefiting from the powerful features and algorithms offered by this software. It is, of course, always possible to adjust the numerous parameters of *PHD2* if one wishes to refine the results of autoguiding.

AstroPiBox has been tested with the following mounts (either in direct connection or with an ST4 port): HEQ5, NEQ-6, CA-EQ6, EQ8, Vixen GP-DX Sky-Sensor, Astrophysics, Avalon M-Zero, EQ-3-2 / EQ5 GoTo EQ-3-2 / EQ5 motors (with harbor ST4), and EM200. It has also been tested with ZWO, ASI and ATIK cameras.

AstroPiBox integrates a complete INDI manager (the equivalent of ASCOM under Linux) dedicated to astronomy (cameras, telescope controllers, focusing systems, weather stations, etc). The selection of the camera

(continued on page 31)



Vixen Sphinx SXD2 and Sphinx SXP Mounts, with the new highly accurate PFL Polar Scope, are a must for the serious Astrophotographer. Featuring the unique STAR BOOK TEN, with built-in star chart, PEC, Autoguider Port, variable tracking rates, easy to use menus and a high definition color LCD screen. Amazing images are waiting!

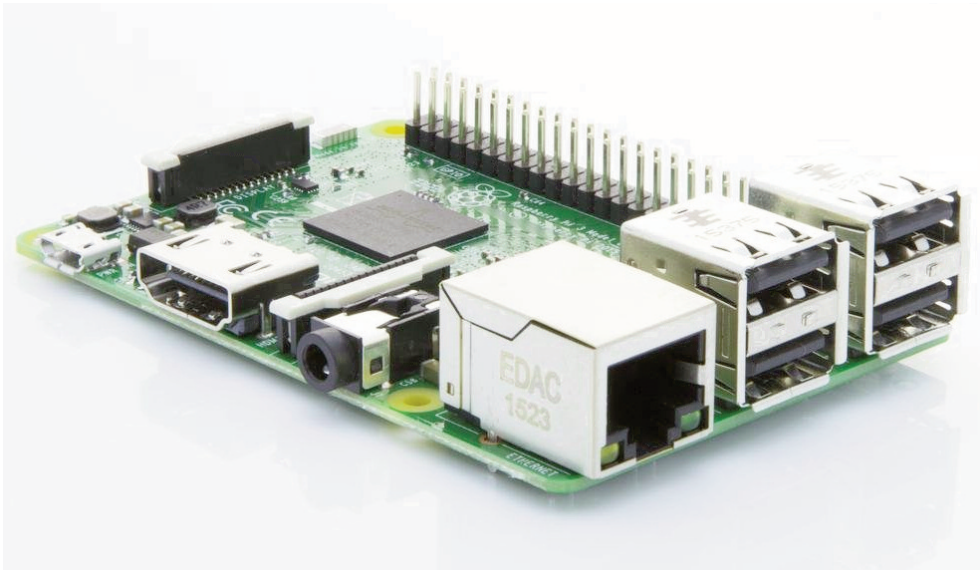
Clear Sky Lab (continued from page 29)

Announces AstroPiBox

to use with *PHD2* is done with a simple click of mouse in the INDI manager integrated in AstroPiBox.

Planetarium, Go-To and Acquisition of Images

AstroPiBox integrates open-source software *CCDciel* and *KStars*. The intuitive interface of AstroPiBox makes it easy to launch these programs. In addition to its stellar mapping functions, *KStars* can control a go-to telescope through the INDI server installed on the Raspberry Pi. *CCDciel* is a simple and efficient tool for acquiring images from a camera connected to the Raspberry Pi.



Astrometric Resolution

AstroPiBox also integrates an astrometric resolution engine that is specifically focused on the Raspberry Pi platform (no Internet connection required). Simply specify the image you are trying to solve in the interface, as well as the approximate sampling of the sensor, to get the astrometric resolution in a few seconds.

Simulation of Light Pollution

AstroPiBox integrates an original tool to simulate the light pollution produced by public lighting, making it easy to search for the most suitable sites for astronomical observation. Simply specify a point and surrounding area of interest, and AstroPiBox will produce a map of light pollution within a few seconds.

Other Functions

AstroPiBox TouchScreen, the version of AstroPiBox that incorporates a 7-inch screen, provides five dedicated buttons for easily adjusting the screen brightness. In addition, a night-vision mode is available to switch the AstroPiBox software display to red.

Proposed Models

Clear Sky Lab plans to offer the system in four versions: **(1)** AstroPiBox SD, a micro-SD card containing AstroPiBox that is ready to insert into the user's Raspberry Pi 3 for integration into a user environment; **(2)** AstroPiBox Basic, a Raspberry Pi with a metal housing and power supply, ready to connect to a screen in HDMI or on a network in VNC mode for integration into a fixed observatory, **(3)** AstroPiBox TouchScreen, consisting of the Basic package, plus a 7-inch touch screen, for an ultra-portable platform for autoguiding and field-mount control; and **(4)** AstroPiBox Laptop, a PiTop with a built-in battery, keyboard, touchpad and 13.3-inch screen, for a self-contained portable platform for autoguiding and field-mount control, as well as for fixed-point control.

Availability

AstroPiBox is in the final stages of development and testing. If you are interested in this product, please contact Clear Sky Lab via email at Contact@cosmodiff.com.

For more information, please visit their website at http://astropibox.com/ .

SEE THE UNIVERSE LIVE AND IN COLOUR WITH

MALLINCAM

NEW! The MallinCam Micro KIT

Deluxe camera body with 6.5' wired remote control, RS485 computer socket ready, 1.25" filter-threaded adapter, DC power cable, DC 5 port cable, 0.5x focal reducer with 25mm spacer, BNC to RCA adapter, 7" colour monitor, 25' power/video cable, choice of ICX672 EXview HAD II sensor or ICX810/811 Super HAD II sensor.

The new MallinCam Micro Series is a small video CCD camera that can take exposures from 1/100,000 second to 17 seconds, making this a versatile camera with any object viewed live on a monitor. The Micro Series camera has been custom-made to our specifications and features several improvements, including:

- A full heat shield over the main board that keeps heat away from the plastic CCD sensor to reduce hot pixels
- A 1/3" 960H EXview HAD II CCD sensor (a Super HAD II sensor is available)
- A complete extensive menu is available
- A 700 TVL processor through a BNC 75 ohms output

$249.99

The MallinCam SkyRaider DeepSky Series

After years of designing and testing under all operative conditions, MallinCam presents the next generation of astronomical video CCD cameras. As well as live observation, the SkyRaider DeepSky Series can take images and video recordings. Our software packages feature the most advanced live video-imaging system available.

Features:

- Handcrafted in Canada
- Up to one-hour exposure (you'll never need that long!)
- Dual independent memories for image/camera control
- Zinc aluminum alloy construction for unmatched durability
- Sealed multi-coated optical window with 350nm to 950nm range
- Full live-video mode, full-screen selectable
- Full imaging capabilities

$699.99

NEW! The MallinCam SKYRAIDER NETBOOK KIT

NOTHING ELSE TO BUY!

Have you always wanted to get into video astronomy? Perhaps imaging the night sky? Look no further. MallinCam has bundled a high-tech kit just for you.

It includes a SkyRaider 1.2-megapixel colour USB camera/guider, 15' of premium USB cable, a guider cable, a 1.25" filter threaded adapter, a 10.1" NetBook computer with Windows 10 and NetBook charger. The NetBook has two full-sized USB 2 sockets, HDMI output, expanded slot for micro card, WiFi, Ethernet socket, Intel processor and more!

Camera features:

- Passive sensor cooling
- Carefully selected Aptina ARO 130 colour or mono sensor available
- 3.75 x 3.75 pixels size
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- MallinCam unique Dark Frame Correction (no Peltier cooling needed!)
- Built-in ST4 autoguider port

NetBook features:

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- Windows 10 loaded
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SEE THE UNIVERSE LIVE AND IN COLOUR WITH

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The MallinCam XTERMINATOR

The MallinCam Xterminator is the finest, most advanced video CCD camera ever created for astronomical work by anyone. It has a new 14-bit DSP processor, dual preamps and dual bias algorithm, allowing continuous automatic adjustment of the CCD sensor regardless of the exposure. It also has the latest ICX828 EXview HAD II CCD ceramic sensor (CirDIP), available in Class 1 astronomical grade and Class 0 grade as an option. The new A/D converter to DSP has been reconfigured to deliver the cleanest image ever seen in a live-video CCD camera, even with short exposure times.

Features:

- Sealed CCD chamber with 1/4" optical multi-coated glass
- High-grade argon-gas-filled sensor chamber
- New ICX828 EXview HAD II Series ceramic (CerDIP) sensor
- Large 1/2" Micro Lens Technology CCD sensor
- Anti-dew coatings on the CCD sensor and internal optical window
- New Holtek dual preamps configuration for greater gain
- New 14-bit DSP
- New A/D converter configuration at the DSP
- Correlated double sampling
- Good suppression of CCD output low-frequency noise is achieved through the use of S/H-type correlated double sampling
- A high S/N ratio is achieved through the use of an AGC-type dual amplifier, and high sensitivity is provided by a wide cover range
- An auto offset circuit provides compensation of output DC offset voltage fluctuations due to variations in AGC amplifier gain
- New dual bias control for perfect control of the CCD sensor
- Cooling selection: OFF (idle), –5°C, –20°C via software

Starts at

$1,599.99 (U.S. FUNDS)

(Xterminator 27K model)

NEW! The MallinCam StarVision

The MallinCam Vision is our smallest video/imager, featuring the Sony ICX825 EXview HAD II CCD colour camera made with an 11mm (3/4") diagonal sensor. Ideal for "HyperStar" telescope configuration and motorized Alt-Az mounted telescopes. Measuring 2 x 2 x 1.5 inches, this new up-and-comer camera will fit on any telescope. The software has been written to simplify operation for new electronically assisted astronomy (EAA) observers. The package includes a lockable 15-foot-long USB 2 cable. Professionally built all-aluminum and stainless-steel construction with C mount and 1.25" adapter. This professional-grade camera will satisfy the most demanding live-video EAA with superb live sensitivity. Outstanding features, such as low noise, high definition and superior colour reproduction, make the MallinCam Vision plug-and-play interface through a PC a breeze to use.

$1,099.99 (U.S. FUNDS)

The MallinCam UNIVERSE

The MallinCam UNIVERSE represents years of design and research in a colour CCD camera that is capable of live constant refresh with a maximum download of one second per frame. The Constant Refresh System (CRS), a first in a CCD camera, downloads a live image for full-frame review on your computer monitor. The camera acts as a video system, displaying a non-stop new image at every exposure.

The MallinCam UNIVERSE is 100% USB 2.0 controlled, and the image is also transferred through USB. A deep-cooling system with a sealed sensor chamber allows cooling to reach –45°C to ensure the lowest noise and dark current where, in most cases, a dark frame is not generally required. **A first in the industry.** Taking publication-quality images is now possible and easier than ever with this new system. A constant live image is displayed for those who wish to use the camera as a live observing system. With its super-large sensor, its total optical diagonal size of 28.4mm across and its large pixel size of 7.8 x 7.8 microns, the camera excels in delivering live colour images. The CCD sensor has a total of 6.31 megapixels. The sensor's horizontal size is 25.10mm, and its vertical size is 17.64mm. The active pixels (6.11 mp) deliver a total size of 3032 x 2016. The New MallinCam UNIVERSE can also be switched from colour mode to black and white with a click of the mouse.

Live processing is done on the fly using features such as full histogram adjustment, full gamma range, full contrast range and auto white balance or manual RGB colour balance.

The unique "Hyper Circuit" found on all other MallinCam systems has been incorporated into this new design, allowing the MallinCam UNIVERSE to deliver a total variable gain of 26.06+ db, a dynamic range of 80 db and a signal-to-noise ratio of 60 db.

The MallinCam UNIVERSE comes complete with a 5-metre USB cable; a 2" threaded adapter; a 1.25" converter, allowing the use of an optional 1.25" eyepiece adapter; 110 volts AC to 12 volts DC power supply; driver; and software CD-ROM.

$1,899.99 (U.S. FUNDS)

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THE ORIGINAL

NIGHT SKIES NETWORK

Nightskiesnetwork.ca was created in 2009 to allow individuals to broadcast the night sky live on the internet using astronomical cameras connected to their telescopes. The site now allows educational institutions, such as universities, colleges, high, middle and elementary schools and astronomical societies, to broadcast in private sessions to their students and clubs' membership. Anyone who thirsts for astronomy-related observations can log in as a guest or join in as a viewer or as a broadcaster of live observations for free. There is no cost to use this service.

Broadcasts include live views of deep-sky objects, the Moon, the planets and the Sun (with special solar filters), when weather permits. Broadcasters on every continent use their private observatories or the observatories of their clubs or educational institutions.

There is only one nightskiesnetwork.ca—the original on-line site serving the astronomy community since 2009. Watch astronomers around the world sharing their live telescope observations, and chat with the broadcasters. More than 13,000+ members and over 300 broadcasters use this free service.

For more information, please visit nightskiesnetwork.ca and join the live on-line star party!

Lunt LS152T Double Stack

Is Double Stacking Worth It?

By Phillip Benson

Image 1 - The DSII module for the LS152 arrived well packed and protected.

Let's be honest, solar astronomy used to be quite bland. Unless, that is, you had a few thousand dollars at your disposal. How things have changed! Thanks mainly to a fall in prices during recent years, the choice of kit for solar observing is now much better and solar astronomy has rightly claimed its place on the amateur astronomy scene. While many choose to buy a separate etalon and blocking filter combo to add to their existing telescope, others prefer a dedicated system and I have always counted myself among this group.

There is also the option of adding a second (or even a third) etalon in the same system to reduce the effective passband. A system with two or more etalons will produce a fainter but more detailed solar disk, and in this feature, I want to explore the reasons why that makes a difference and describe my own experience with double stacking.

My own solar kit consists of a Lunt LS152T dedicated Hα solar telescope that I bought second hand from someone in Belgium. He sent me a couple of sample images, and from then on, I knew that solar imaging was the way forward for me. The LS152T is now permanently set up in my observatory. For portable use, I have one of its smaller siblings, a Lunt LS60T.

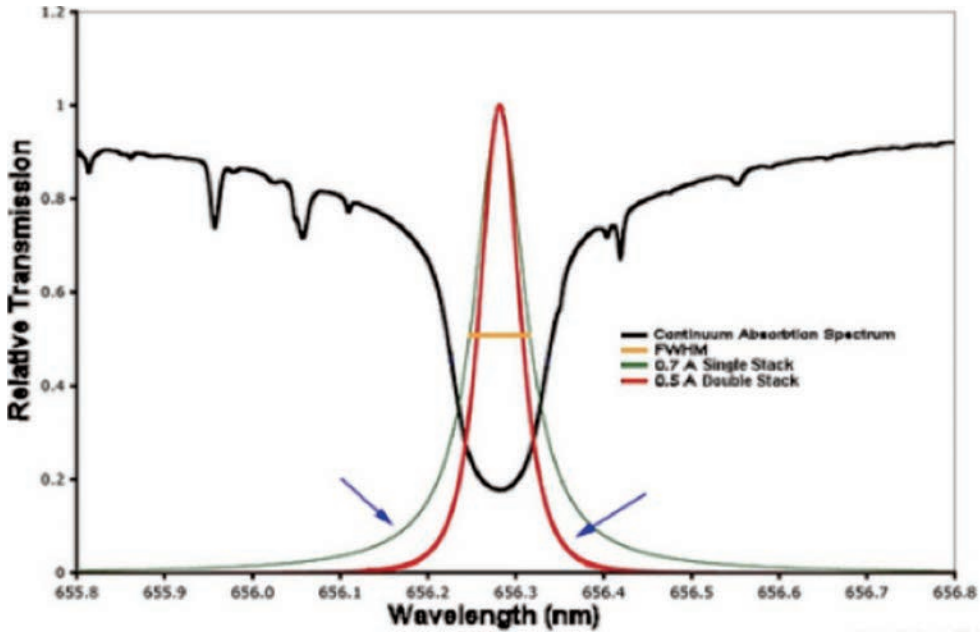

Diagram 1

Light gathering power is not an issue with solar astronomy for obvious reasons. So, what advantage can you gain from buying a large-aperture refractor for observing the Sun? The answer is simply resolution. When used with the appropriate blocking filter, the LS152T provides excellent resolution along with a large image scale. Of course, you still need good seeing to get the best performance. Even though the telescope only has a basic achromatic lens, the cost of a new one is comparable to a top-quality 6-inch apo triplet refractor. You are paying almost entirely for the 60-mm etalon.

If you want to double stack an LS152T, though, you have a problem. Lunt only manufactures separate filters up to 100 mm. On its own, the LS100F will relieve you of the thicker end of $5000. Attach one of those to the front of the telescope, and you will be losing just over two-thirds of the telescope's full aperture. There must be a better alternative, and fortunately there is. Even better, it is also less expensive!

As well as the option of an external add-on filter, Lunt also offers an internal double-stack module known as the DSII. Like its smaller siblings, the DSII module for the LS152T sits between the primary etalon and the focuser. It isn't light by any means, weighing in at just over 2 kilograms. With just one of the three supplied adapters in place, the DSII adds about 2.5 inches to the overall length of the telescope. Is it worth it? At nearly $3000, many would probably say it's not, but having recently come into some cash from the sale of a mount and always being the curious type when it comes to trying out new gear, I decided to take the plunge and buy one.

Before I describe my experience so far with a double stacked LS152T, I want to provide some general information about what you will gain with a double-stacked system, and why. That will serve to dispel a myth or two along the way. A full description of the physics is quite involved, so I have done my best to summarise the important points.

Single Stacking and Double Stacking Compared

The primary etalon of the LS152T

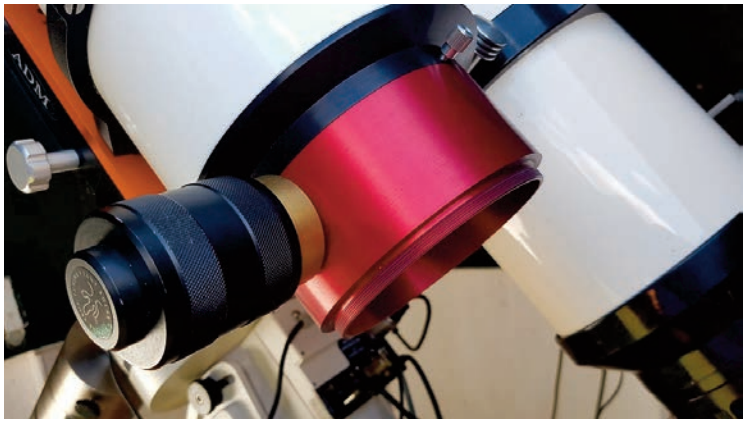

Image 2 - LS152T with its cone adapter and focuser removed.

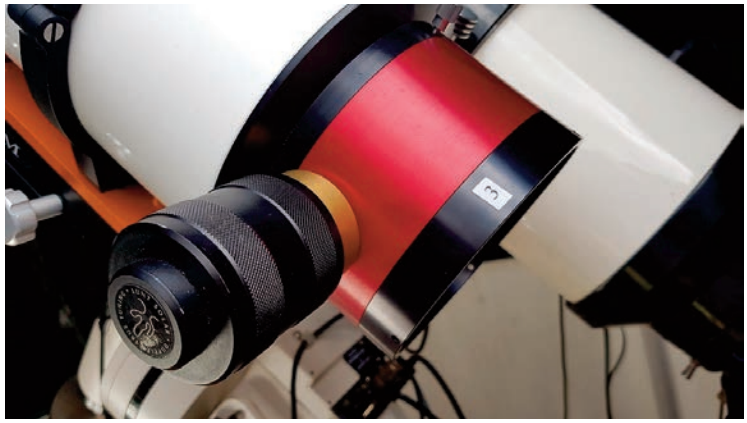

Image 3 - The DSII adapter secures onto the exposed thread of the primary etalon.

has a 60-mm aperture and has a stated passband of <0.7A. The inclusion of the "<" sign means the FWHM (orange line in **Diagram 1**) of the filter will not exceed 0.7A.

The transmission band of the single-etalon (<0.7A) system is the *upward* pointing green curve in Diagram 1. The black line (top) shows the profile of the absorption line due to Hα in the solar spectrum. The central wavelength, or CWL, of both curves is identical for both curves and lies at 6562.8A.

Diagram 1 shows that there is a certain amount of light "leakage" from the photosphere outside the limits of the Hα line (left arrow). This manifests itself in the eyepiece or camera as a kind of "double limb," which can be seen quite easily when seeing conditions are favourable. You will often see this second outer limb referred to as the spicule layer. Higher power images will show the spicule layer to have a jagged appearance with prominences seeming to extend naturally out of it.

With a second etalon added to the system, the transmission curve (red line in Diagram 1) is horizontally (but not vertically) squeezed – that means a

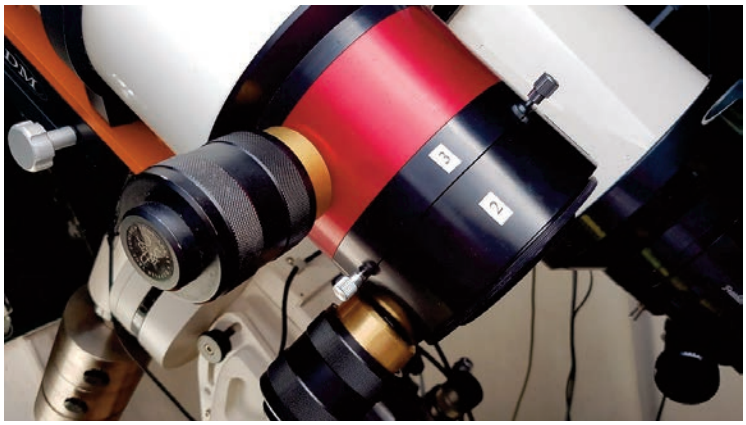

Image 4 - After the thumb screws were inserted into the adapter, the DSII is secured into place.

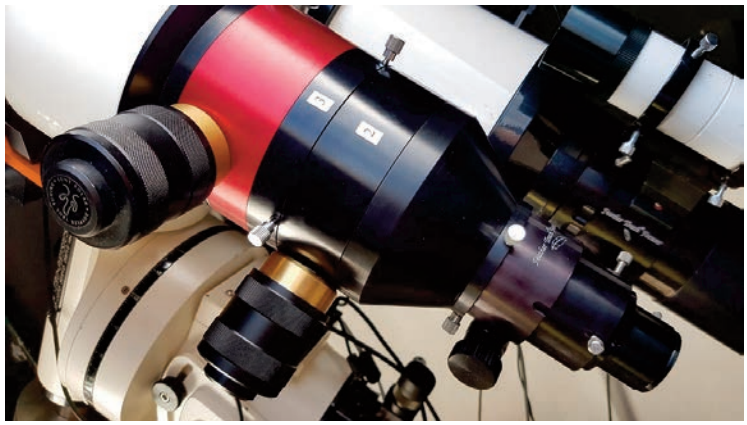

Image 5 - The stock focuser unit completes the assembly.

smaller wavelength range getting through to the detector. The solar image looks fainter, because the extent of light leakage from the photosphere (right arrow) is reduced. Surface detail is improved, because a higher proportion of the total light producing the image is now coming from the Chromosphere.

The last thing to point out is that, since the relative transmission intensity at the CWL of both single and double stacked curves is the same, the brightness of any prominences is also the same. It is only the lower surface brightness of the image in a double-stack system that tricks our brains into thinking that the prominences appear fainter.

Double Stacking the LS152T

The DSII module for the LS152 arrives well packed and protected as you would hope and expect. Inside the box,

you get three adapters labelled 1, 2 and 3 respectively (the DSII itself is labelled 2), along with some thumb screws, an Allen key and fitting instructions (**Image 1**). Considering the cost of the module, I was a little disappointed that I didn't get a shiny aluminium, lockable carry case as I am used to with other Lunt products.

The module arrives with the three adapters secured to it with some grub screws. The first step after unpacking is to remove the grub screws and have the thumb screws ready. That makes life much easier when it comes to fitting the module at the telescope.

Installation is straight forward and quick. In my case, I only needed the one adapter labelled with a 3. I started out by removing the focuser and cone adapter (**Image 2**) and then securing the DSII adapter onto the exposed thread of the primary etalon (**Image 3**). After inserting the thumb screws into the adapter, I secured the DSII into place (**Image 4**). Finally, I screwed the focuser unit back on (**Image 5**). I believe there have been some small design changes to the LS152T over the years, and so you may need to use more of the adapters.

With the DSII in place, the telescope is now both longer and heavier, so it will need to be rebalanced. The design is fully in-keeping with the rest of the telescope, so the main visual impact from fitting the DSII is the second pressure tuner knob, which can be rotated to whatever position is convenient.

There is a well-known curse in the astronomy world in so far as, whenever someone announces they have just got some new kit, that is the signal for cloudy skies for the next few weeks. That was certainly true for me when I got this, and I started to believe I would never see the Sun again! All those near and dear to me will confirm that, for days afterwards, I constantly had one eye on the sky, and whenever it seemed like there was going to be a break in the clouds, I would make a dash for the dome, get everything fired up, aimed, focused and then wait. Alas, that precious break in the cloud would never seem to quite line up with

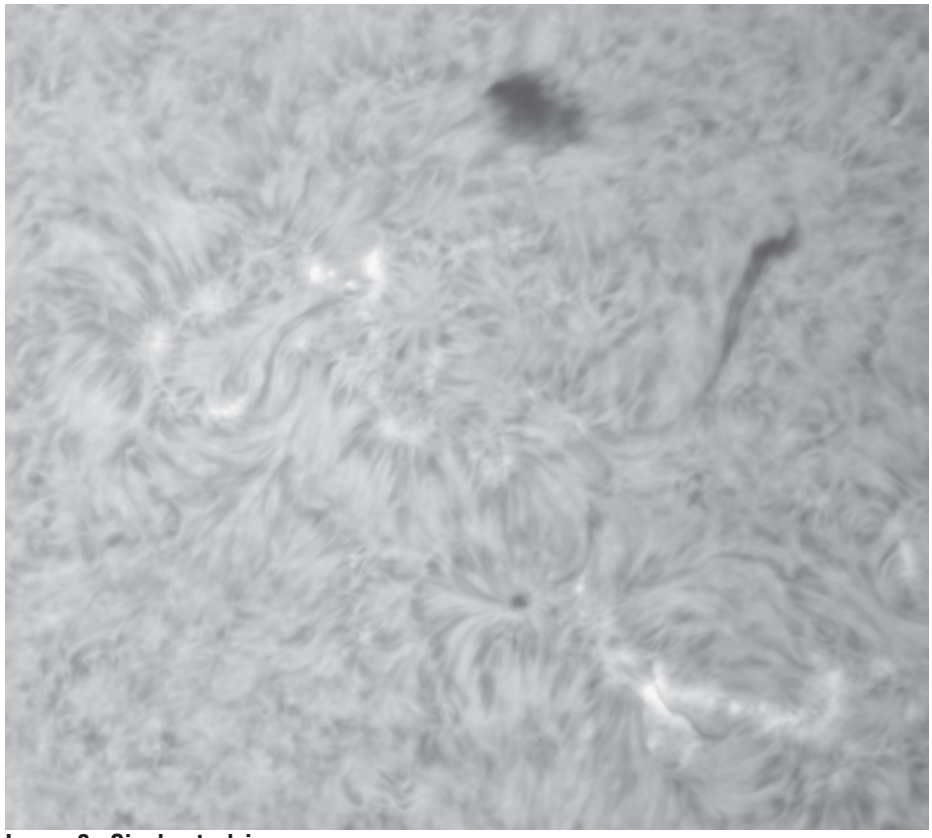

Image 6 - Single-stack image.

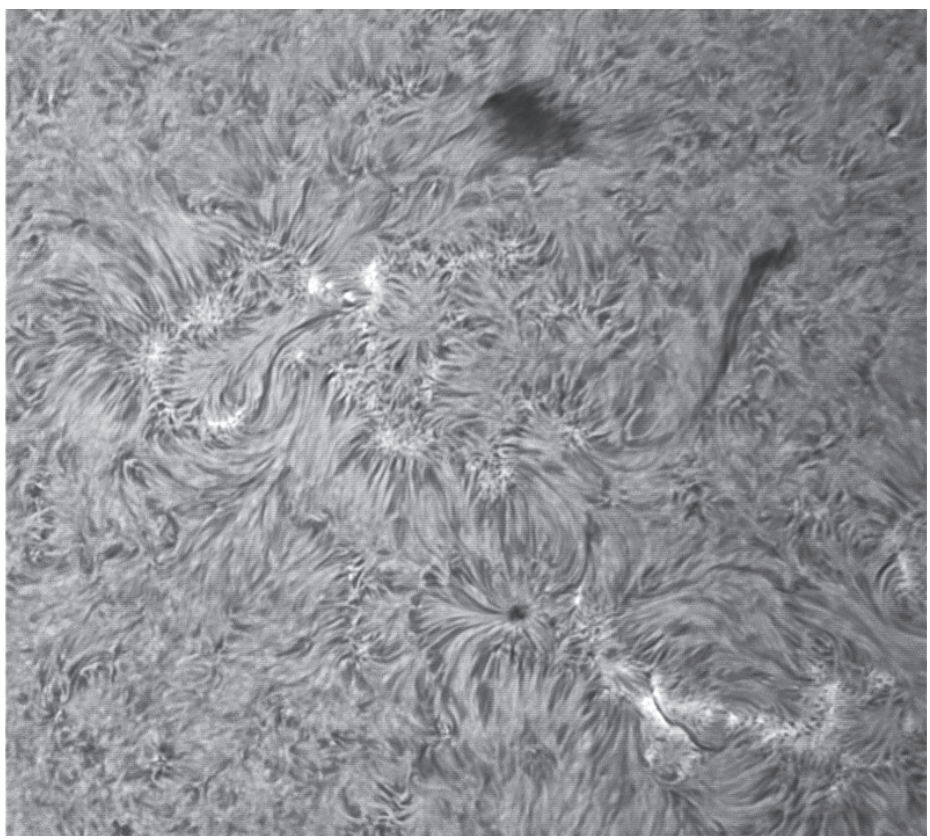

Image 7 - This double-stack image shows significant improvement in terms of resolution and overall crispness of disk detail as compared to the single-stack version.

where the Sun was.

Then finally one afternoon the clouds dispersed, and I was good to go. Since I use my LS152T almost exclusively for imaging, all the testing I have done for this feature was carried out using a PG Flea3 USB3 camera and FireCapture software. My blocking filter is a Lunt B1800 straight-through version.

Lunt recommends that you first set the pressure tuner on the primary etalon to show optimum detail. You then attach the DSII and adjust the second pressure tuner to show optimum brightness. In practice, I found this procedure worked well, and through careful adjustment, I had a pleasingly bright image on the screen with only small exposure compensation added in FireCapture.

Due to the way pressure tuning works, you don't get a sweet spot in the same way as you do with a tilt-tuning system, so it is a matter of finely tweaking the pressure knobs to get the best overall detail. Remember that, when you adjust the pressure tuners, you are effectively scanning through small changes in temperature vertically through the chromosphere.

As I have already mentioned, the DSII and adapter add about 2.5 inches to the back focus of the telescope, so some experimentation will be needed to correct the focus. I found I could discard the 2-inch extension tube I normally use. I adjusted the cameras exposure setting with the DSII in place and then used the histogram in FireCapture to get the image brightness matched as closely as I could with the single-stack image (**Image 6**). **Image 7** shows the best overall result I could get after adjustment of the DSII pressure tuner only. The DSII offers a significant improvement in terms of resolution and overall crispness of disk detail.

Then I turned my attention to the limb and located a small but well-structured prominence. If anything, the fine details in the internal structure of the prominence were brought out more with the DSII in place, and it wasn't noticeably fainter. This confirmed what I described earlier.

So, with improved disk detail along with equal if not slightly better performance with limb detail, the DSII is, for me, a useful addition to what is already a superb solar telescope. Conditions during my testing session were far from ideal, so I can fully expect to see even better things from the DSII in the future. Whether the amount of improvement justifies the price is another matter, and something only you can decide.

As I finish writing this, the same UK dealer where I bought the DSII has just offered to lend me one of Airylabs High Resolution H-Alpha Chromosphere telescopes. Basically, a Celestron C8 EdgeHD specially adapted for narrowband solar astronomy. A report on that scope will follow very soon. ATT

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LUNT SUNoculers

Delivering a "Hands-on" Solar-Viewing Experience

By Gary Parkerson

Image 1 - Lunt's 8x32 SUNoculars, with lens caps in place, shown where the binos are normally found when the Surly Big is parked, resting on its back rack, ready to provide a new guest's first view of Sol.

I sold vacuum cleaners when I was in college – Electrolux, in case you're wondering – and it's no exaggeration that door-to-door sales taught me survival skills more essential to modern life than did the several universities I attended.

"Don't wait for the customer to come to you. Go to them!" It's the underlying tenet of door-to-door sales and is a core premise behind the Pedaling Astronomer Project. I demonstrate astro tech wherever people are gathered outdoors, and showing up on an odd-looking bicycle is a great conversation starter. It gets me in the proverbial door, and as every seasoned door-to-door salesperson knows, the hardest part of the job is getting in the customer's door.

Another key to closing the sale was, "Put the product in their hands," and when it comes to leveraging solar astronomy for outreach, no astro tech delivers enhanced hands-on solar-viewing experiences more naturally than Lunt Solar System's

Image 2 - The SUNocular's front lens caps are captive, as are the hinged rear caps when they are threaded on the included neck strap (not shown here). Although the carry case is showing evidence of daily use under harsh bike-travel conditions, not so the still-pristine SUNoclars.

SUNoculers. I've handed them to kids as young as age six and to seniors in their 90s, and none had trouble, once shown, adjusting interpupillary distance or achieving focus, much less finding the Sun with the binos.

Lunt's white-light SUNoculars come in two configurations: (1) an 18-ounce (510 grams), 8x32 center-focus version with 13.6-mm eye relief and adjustable eyecups, priced at $129US, and (2) a 10-ounce (283-gram), 6x30 "mini" version with individual-focus eyepieces, 9.0-mm eye relief and fixed eyecups, priced at $29.95US.

I requested the 8x32 version, and the sample I received was Lunt's "red" option, although the actual color of its tough rubberized armor looks more coral to me than red. Truth is, though, I prefer coral to red, not that the color of their armoring has anything to do with how they perform.

Speaking of armor, these things are rugged. They arrived in perfect collimation, and they remain in perfect collimation, despite having been transported thousands of miles over cracked pavement – and often over no pavement – in the cargo bags of a too-heavy bicycle with no more suspension than the bit of give its tires provide when inflated to 65 pounds per square inch. The pounding ride of the Surly Big (that's what I call her) has destroyed more than one item of high-end astro tech since we hit the road in May, but the Lunt 8x32 SUNoculars still look and perform like new.

Their center hinge is firm enough to hold interpupillary distance wherever the user sets it, but smooth enough that resetting it is natural and intuitive. Ditto the action of the center focus knob – smooth, predictable and stable. Despite their affordability, Lunt's 8x32 SUNoculars feel solid and exude mechanical quality.

Image 3 - Elementary-school kids enjoying first views of the Sun. Notice the young man in the rear left using the SUNoculars. Most students required a bit of guidance while first trying to find the Sun in the eyepiece of the telescope, but they needed no assistance when using the binos.

The center hinge incorporates a threaded insert for accepting a standard 1/4-20 binocular mount bracket. It's covered with an included screw-on cap when not in use. The eyecups extend out with a counterclockwise twist, and even this action is smooth and predictable, extending the cups in three click-stop stages that help ensure both are adjusted to the same distance.

I don't carry a tape measure or calipers on the bike journey, so have no way of measuring the precise extent of the eyecup extension, but my guess is between 9.0 and 10.0 mm. Whatever the distance, I view sans eyeglasses and prefer the cups fully extended to better shield direct and indirect sunlight when viewing Sol. Those of you who view while wearing eyeglasses will likely need to observe with the eyecups fully retracted to get full benefit of that 13.6-mm of eye relief. When fully retracted, the leading edge of the cups are within a couple of millimeters of the outer

Image 4 - After the young lady in the right foreground viewed of the Sun through the SUNoculars, she helped others use them, while I focused on assisting at the telescope. The SUNoculars are delightfully easy to master!

elements of the eyepieces.

The 8x32 SUNoculars ship with a soft nylon case, a neck strap and front and rear caps. About those caps: I was recently treated by an avid birder to some oh-so-sweet Swarovskis, and although their optics were truly exquisite, their hinged eyepiece caps refused to stay on. Not so with the SUNoculars. The rear caps are joined, as were the Swarovskis, but they fit superbly and remain firmly in place, as do the front flip-down caps. They are perfectly executed and have proven durable enough to withstand the thousands of hands that have already pulled them on and off.

And about that 8x magnification: I learned long ago that, while I am capable of viewing with 7x binos handheld without distracting image shake, not so at 10x. Therefore, the binoculars I use most often for scanning the Milky Way are 7x50s, not 10x50s. Lunt's 8x32 SUNoculars have taught me that my hands are steady enough for pleasing handheld views at 8x, too. Of course, it helps that the SUNoculars are much lighter at 18 ounces than my favorite 7x50s.

Okay, they're refined and durable, but what about the views? Well, given that I've used nothing comparable against which to evaluate them, I can only describe what I've seen through the SUNoculars, and what others have reported seeing. I've seen Sun spots in unexpected detail, given that I was viewing them at just 8x by hand. I've even seen a hint of surface granularity, which I also did not expect at 8x. Perhaps it was my mind's eye supplying those details from memory, but I doubt it. I'm not that imag-

Image 5 - CBSAP solar glasses, a DayStar Quark, SV70T apo refractor and Sky-Watcher Star Adventurer Mount on the Surly Big, and the Lunt 8x32 SUNoculars, all being put to best use in the backyard of a B&B on the Missouri Katy Trail.

inative.

I expected a bright-ish haze surrounding the Sun, but no, there's none of that. These solar-specific binos render a surprisingly dark background sky. On a few occasions, I've seen birds and airplanes silhouetted against the Sun, also in sharp detail. Don't you love it when your expectations are exceeded?!

More interesting to me is what others report when they use the SUNoculars. The most common comment is, "WOW!" Given that the binos deliver so many first views of the Sun, that reaction is not surprising. What is surprising is how many of my guests also say, "It looks like the Moon!" which I take to mean that the white solar disc against the black background sky produced by the SUNoculars is reminiscent of the full Moon against a dark sky, and which I therefore consider a compliment.

I'm also often asked, "What are those black spots?" even after telling guest that they might see sunspots (and they do appear decidedly black in the SUNoculars). You and I are so familiar with the phenomena that we take for granted everyone else will understand what we mean when we describe sunspots. But most of my guests are seeing the Sun for the first time. They have no preexisting expectations of what sunspots look like. And so, I answer, "Good eye! Those are the sunspots I mentioned. They're areas of the Sun's photosphere that are so much cooler than the surrounding areas that they appear dark to our eyes. They are still quite hot and bright – only about 36-percent cooler than the rest of the photosphere, which is a bit less than 10000° Fahrenheit, or 5500° Celsius."

I check the Sun daily with the SUNoculars (assuming skies are clear), now that I carry them everywhere on the Big, and not just because they are so much easier to deploy and share than the solar scopes I carry. I also like that viewing with both eyes is more immersive. But yes, the binos do get more use if only because they require no set up. On days when predominant clouds allow only brief views of the Sun, it isn't worth setting up and aligning a telescope, but the binos are ready in an instant.

Lunt's website reports: "The light of the Sun is reduced to a comfortable 1×10-5 transmission, and all ultra-violet and infrared components are completely and safely blocked." As with the eyecup extension, I've no way of measuring this. Instead, I can only attest that I've now used the SUNoculars hundreds of times without negative impact on my vision. Views of the Sun through the binos are bright, but comfortably so.

For those of us who live in the U.S. or are planning to visit on August 21, 2017, there's a total eclipse of the Sun in our futures. But you already knew that. Anyway, you're going to be very busy that day, helping family and friends get the most out of what for many of them will be a once-in-a-lifetime experience. The eclipse is a great excuse to invest in that dedicated solar scope or solar telescope filter you've been wanting, and you'll want to have enough solar glasses on hand for all. But while solar glasses are as intuitive to use as Lunt's SUNoculars, and are also blessedly affordable, they don't magnify the solar image.

8x is a meaningful enhancement that yields a far more intimate perspective of the Sun. Add that they provide an intuitive, hands-on experience, and you begin to see what makes these solar binos such an effective bridge between also-intuitive but zero-magnification solar glasses and the hands-off, stationary experiences of higher-resolution solar telescopes.

Bottom line: I do solar-centric astronomy outreach almost daily these days, and having used Lunt's 8x32 SUNoculars in that role, I don't want to imagine being without them – not day-to-day and certainly not on the big day of the 2017 Great American Solar Eclipse. My advice? Get yours now before demand overwhelms supply, because just as with hotel rooms and campsites along the eclipse path, those who wait too long to score SUNoculars of their own will find themselves left out. Just saying. ATT

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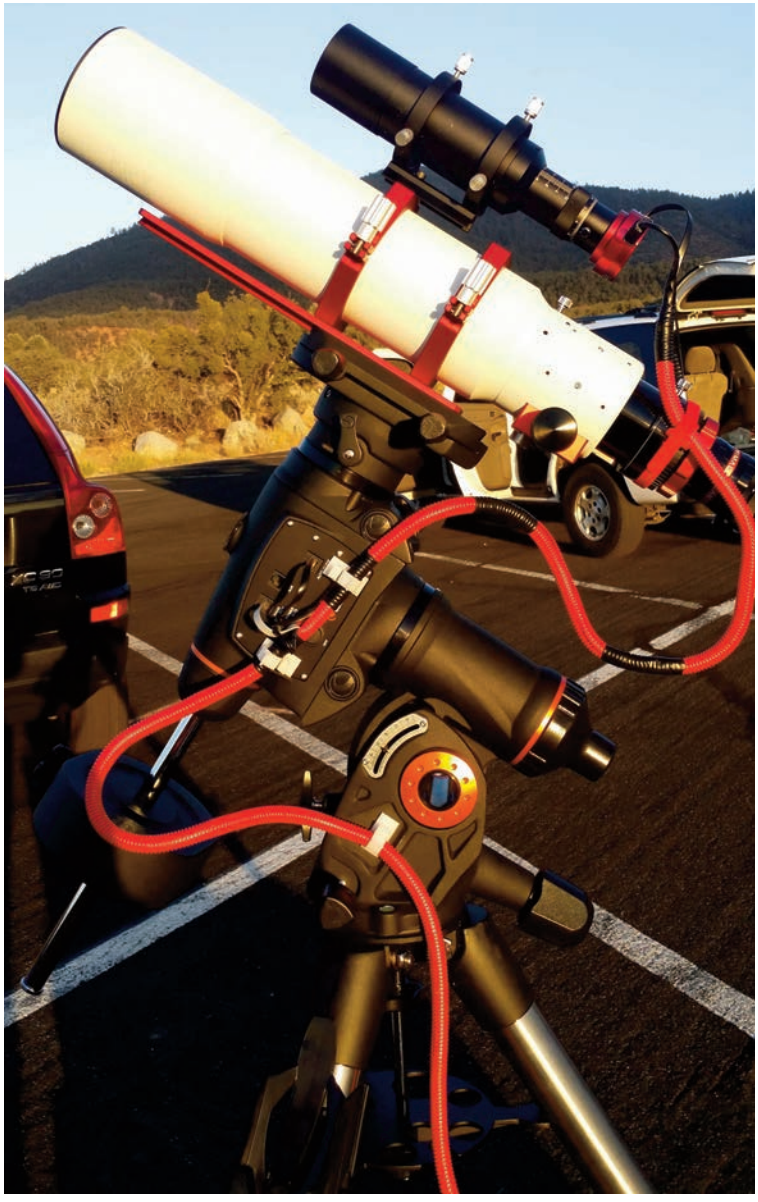
PRIMALUCELAB AIRY 100ED

A Doublet that Exceeds Expectations!

By Simon Tang



I'm no pro compared to some of you – okay, compared to most of you. In fact, I'm so not a pro that I have only been doing astronomy since the beginning of 2016. I didn't buy my first telescope until April of the same year. So, what qualifies me to tell you about the PrimaLuceLab AIRY 100ED? Nothing really, except that, unlike some who attempted entry brand new into the arena of astronomy and astro tech, I survived the pitfalls, booby traps and endless hours of head scratching and blank stares when acronyms were uttered forth like a spell only Gandalf the Grey could mutter without the lords of hell raining havoc. Along the way, I managed to learn a thing or two.

My default strategy for confronting anything as intimidating as astro tech is humor, so I hope, no matter your skill level, you'll appreciate a lighter approach to this telescope review. And in all seriousness, there are few things I hate more than seeing someone who has invested hard-earned cash in a first telescope with which they struggle, if only because of that unnecessary intimidation factor. And so, I'll share what I recently learned in the hope that other newcomers might also survive to graduate to the ranks of the more experienced enthusiasts of this great community.

Out of the Box First Reaction

Returning home with the non-descriptive brown box and removing the tape, I was presented with a bubble-wrapped hard case inside which sat a PrimaLuceLab AIRY 100ED Doublet Apo. This Italian-designed (but sourced in Taiwan) refractor is the brainchild of Filippo Bar-

Image 1 - The AIRY ED100's lens features an element of FPL-51 from Ohara, Japan, treated with multiple layers of gorgeous antireflection optical coatings. Not a speck of dust cluttered its pristine surface.

daschia and Omar Cauz, who have many years of experience in radio and astrophotography. Their passion to create quality products has been likened to Ferrari producing high-end sports cars for the world to marvel.

But my first glance at the AIRY ED100 evoked a different comparison. After removing the crunchy plastic wrap, the heavy aluminum tube with PrimaLuceLab's distinct red décor reminded me of the William Optics FLT98. At first glance, the only real difference seemed that the AIRY had red accents, not gold.

But a quick search on the Internet revealed that the AIRY ED100 was different, after all. Of course, it's a doublet, where the FLT98 is a triplet, and its aperture is a full 100 mm versus the FLT's 98 mm, but like the FLT, the AIRY is strikingly beautiful!

As I lifted the tube out of its case to

inspect its cool white surface, I felt like I was holding a serious piece of machinery ready to strike down any stray missiles that dared to cross my path. The perfectly machined parts come together to form a cylinder of seemingly absolute viewing power. It certainly had what it needed in the looks department!

I cracked open the lens cap for the first time, and the lens set glowed with the telltale colors off multiple layers of quality antireflection optical coatings. Not a speck of dust cluttered the pristine glass surface (**Image 1**).

Anxious to test the scope, I proceeded to attach it to my mount, and that's where everything came to a screeching halt. The AIRY ED100 included mounting rings (**Image 2**) – beautiful, heavy-duty red ones that matched its other components perfectly, in fact – but there was no dovetail. This

Image 2 - The AIRY ED100 included mounting rings beautiful, heavy-duty red mounting rings, but no dovetail.

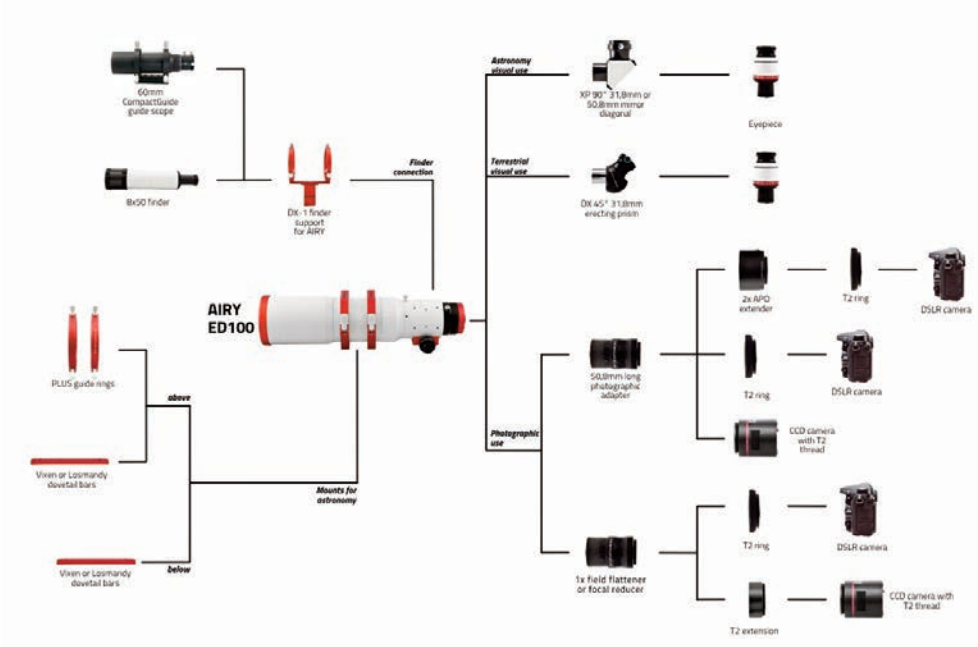


Image 3 - PrimaLuceLab's PLUS accessory system includes everything you need to equip the AIRY ED100 for whatever role you choose.

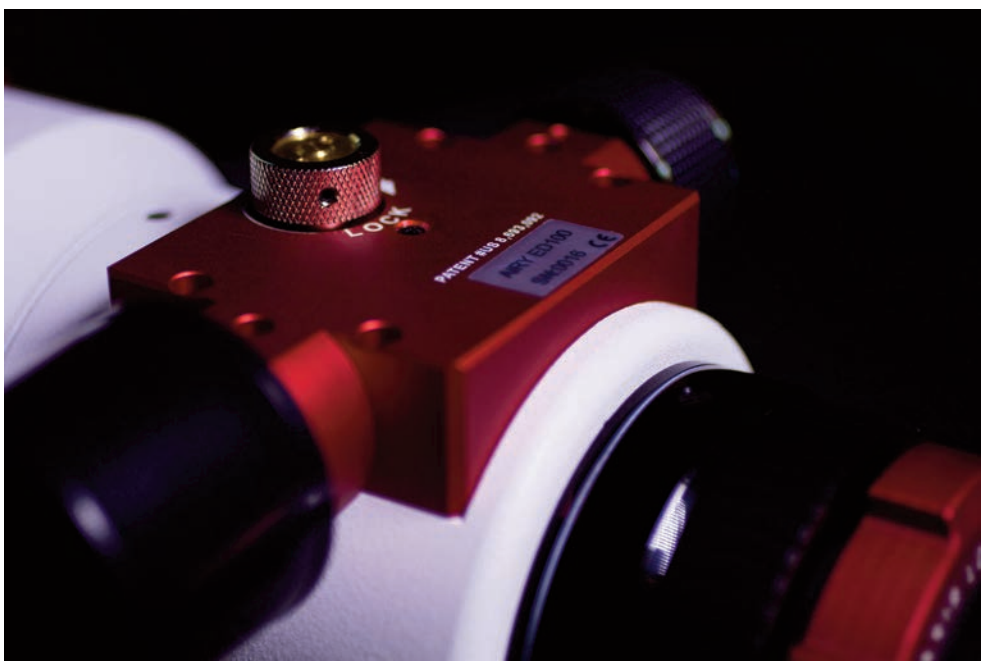


Image 4 - The highly refined 2.7-inch Hybrid-Drive rack-and-pinion focuser.

is a premium telescope, so I was initially disappointed that a dovetail wasn't included.

Upon further reflection, I realized that, from PrimaLuceLab's perspective, including a mounting dovetail would have been a 50-50, hit-or-miss proposition, at best. As it happened, I use a Losmandy-style dovetail and had one handy. Inclusion of a Vixen-style rail with the AIRY 100ED would have been a miss in my case.

PrimaLuceLab produces a comprehensive line of accessories for its refractors that it calls its PLUS system, for "Prima Luce Universal Systems," and these accessories include both Vixen- and Losmandy-style dovetails that fit both the top and bottom mounting holes of the included split rings. A chart of the full line of accessories is included in **Image 3**.

When you invest in a telescope of this caliber, you are paying for precision and quality of design. After all, you're investing in Italian-badged luxury; it makes sense to also invest in accessories designed specifically to compliment that telescope. PrimaLuceLab's comprehensive PLUS-system approach allows you to select only those components you need and to forgo the cost of accessories you might not need, like duplicative Vixen-style dovetails.

Part of the beauty behind investing in such quality workmanship is the knowledge that everything is crafted to a precise standard. The use of all things metric, from the size of each screw, to every possible attachment, makes life a little easier when figuring out how to connect the assortment of accessories we come to rely on when standing outside in total darkness.

Let's Get Technical

The AIRY 100ED's apochromatic optical design ensures minimal chromatic aberration, despite deploying the less-popular and often-misunderstood doublet element. At 100-mm aperture and a focal length of 600 mm, you're treated to a wide view of the sky, sure to fit even the largest of extended objects dead center and still leave room to park your Ferrari in view.

The highly engineered 2.7-inch Hybrid-Drive rack-and-pinion focuser (**Image 4**) moves back and forth with

ease and enough resistance to make sure when you sight the edge of that razor blade from 1000 meters away, you know it's going to stay in focus.

At a hefty 5 kilograms – that's 11 pounds to all you imperial troopers out there – the AIRY 100ED's metal tube is no feather weight, and rightly so. When connected to your mount, it forms a good solid platform on which to hang the various accessories required for imaging stars, or maybe just your neighbors garden shed.

Among the components that set the AIRY 100ED Hybrid-Drive focuser apart from those of run-of-the-mill refractors is its OnAxisLock (**Image 5**), which features a positive, self-centering mechanism, as opposed to standard thumbscrews, that grabs hold of whatever accessory you put into it and tightens its grip without leaving a mark. The system also allows for some serious weight to be gripped, meaning that even the heaviest of cameras will stay firmly in place and not slide out and hit the deck.

Image 5 - PrimaLuceLab's OnAxisLock features a self-centering locking device rather than typical thumbscrews.

The AIRY 100ED allows you to do both visual and photographic astronomy using an assortment of PLUS adapters for attaching your specific camera. Of

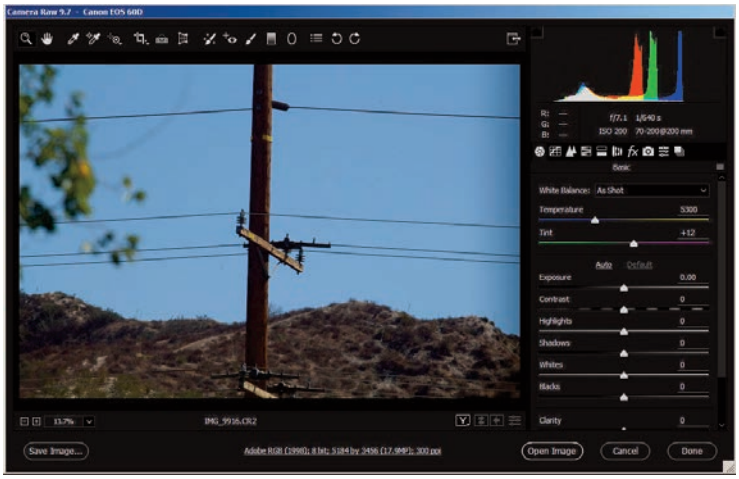


Image 6 - Canon EF L 70-200.

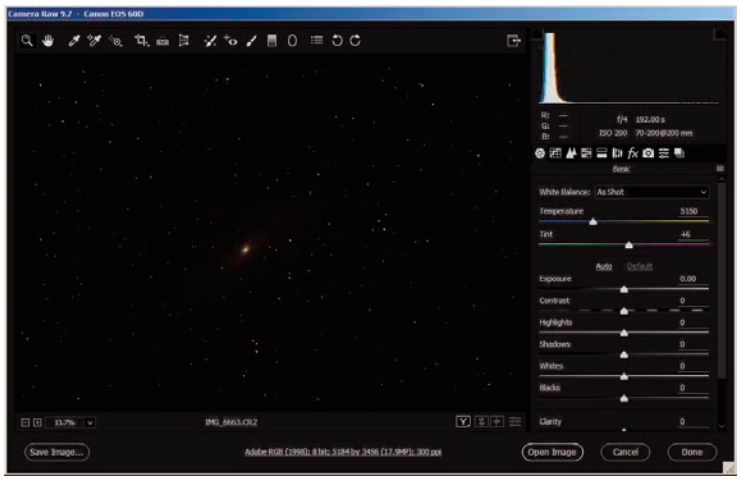


Image 7 - Canon EF L 70-200.

course, all these pieces are at an extra cost. PrimaLuceLab also offers a 1.0x field flattener. As with the dovetail, I wondered at first why the company didn't simply include the field flattener with each AIRY 100ED, but then I remembered that not everyone shares my focus on wide-field astrophotography. If you purchased the scope to match with a DayStar Quark and energy-rejection filter, you wouldn't want to have to absorb the additional cost of a field flattener you'd likely never use.

Now for the engine of this beast, the beating heart and soul, the very stuff astronomical dreams and nightmares are forged from: the lenses, made in Ohara, Japan, of FPL-51. This type of glass is rock hard. In fact, it's harder than rock! It doesn't expand and contract like other glass, meaning that when under pressure to perform, it doesn't go weak at the knees.

(continued on page 59)

Introducing the AZ Mount Pro

featuring *"level and go"* intuitive **GOTO** setup

We call it "level and go", the term used to describe our new AZ Mount Pro's simple set up routine. Using its built-in precision level indicator, the operator simply levels the mount and turns on the power; this capable computerized alt-azimuth telescope mount takes it from there. Utilizing the on board 32 channel GPS receiver and built-in position and angular detection sensors; the AZ Mount Pro calculates its global position as well as the telescopes orientation. Automatically the mount slews the instrument to an easily identifiable bright object in the night sky. The user need only confirm a bright object is in view, to activate tracking and GOTO functionality.

AZ Mount Pro features and highlights

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- 33lb primary payload and 10lb secondary payload capacity, with a mount weighing only 13lbs
- Whisper quiet low-power consumption stepper motors
- Go2Nova® 8407 hand controller featuring 212K+ object library with an 8 line illuminated LCD screen
- Built-in WIFI adapter for full ASCOM, iOptron Commander™ and Sky Safari wireless control
- Zero backlash drive system
- Serial port for computer control and firmware upgrades
- Retractable counter weight shaft
- Position memorization at power interruption
- Die-cast aluminum body
- 3-Point easy level adjustments on tripod
- 6 inch dual dovetail saddle (Losmandy/Vixen, styles)
- Stands a mere 10 inches tall (mount head only)
- Built in 32- channel GPS receiver
- Automatic position and angular detection sensors
- Two year warranty

AZ Mount Pro product numbers
#8900 AZ Mount Pro with tripod
#8920 AZ Mount Pro, head only

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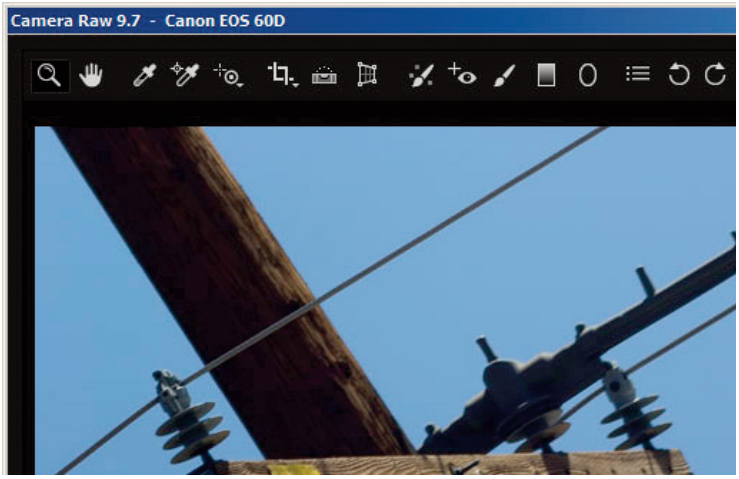

Image 8: - AIRY 100ED.

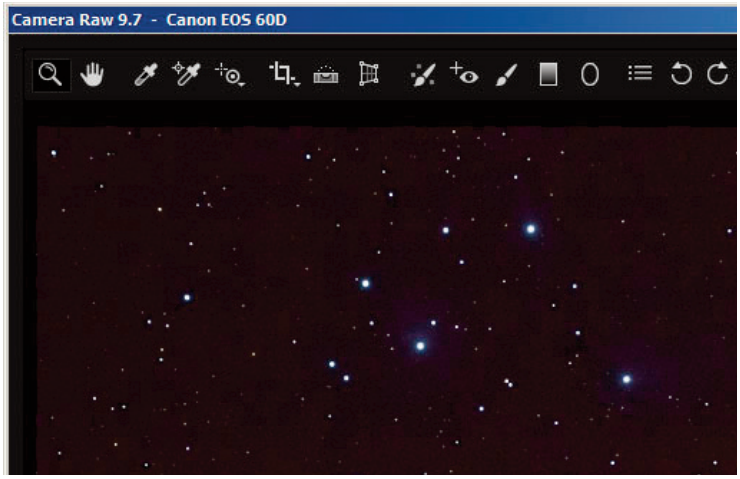

Image 9 - AIRY 100ED.

(continued from page 56)

However, this doublet is not without its draw backs. There's a bit of residual chromatic aberration, enough to annoy the most discerning observers when viewing ultra-bright objects at high magnification, but high-magnification planetary views are not why you invest in a fast refractor. You buy it for long-exposure, wide-field astrophotography, and when imaging with monochrome CCDs, using narrow-band filters to produce color images, the resulting images are perfection.

Let the Games Begin

Before we start showing images of nebula and swirling clouds of stars more commonly known as galaxies, we compared the scope to what may at first blush seem an unlikely optic against which to reference an astrophotography system, a Canon L-series 70- to 200-mm Lens.

Why compare a telescope to a cam-

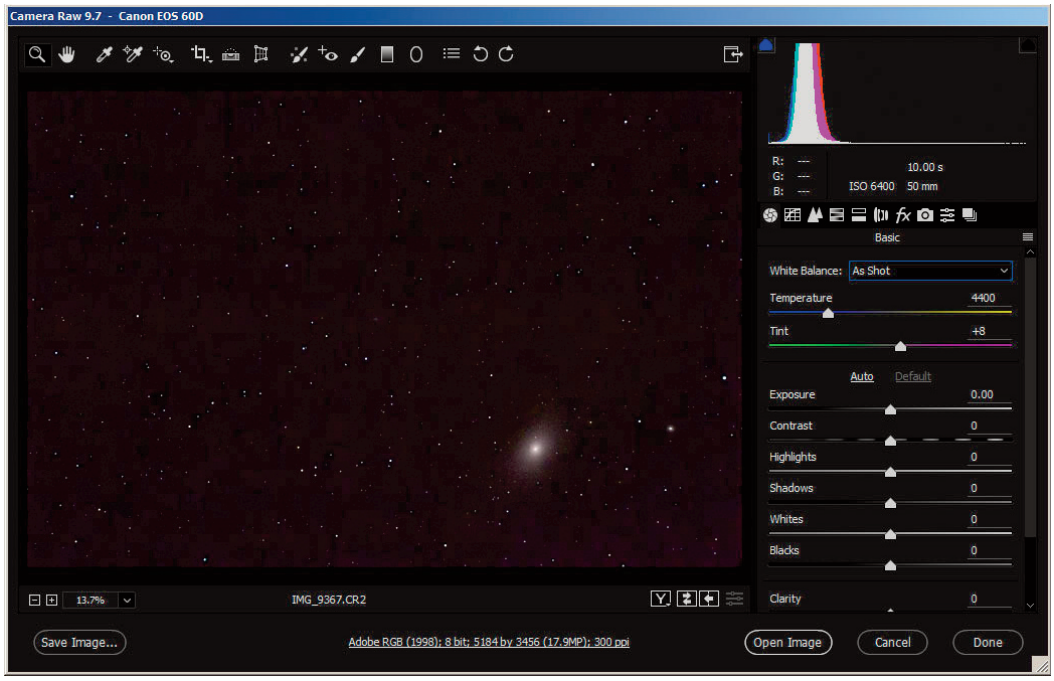

Image 10 - AIRY 100ED.

era lens? The idea of comparing your refractor with a reflector telescope is like comparing a Ferrari 488 to a Ducati 1098S. Both can get from point A to point B in neck breaking speeds, except, one has got four wheels. The other only has two, so you wouldn't do that. But comparing an apo refractor to a photograph lens is comparing four wheels to four – they're both lens systems. Sure, the 70- to 200-mm's maximum focal length is just a third that of the AIRY ED100's 600 mm, but the test is to compare the refractor's optical quality with a tried-and-trusted tool that most photo nerds know well.

Image 11 - Lagoon Nebula.

We took similar shots of an exciting wooden pole outside our window and settled in for some real science. We let the camera decide the color balance automatically and examined the histograms for every critical piece of information. (**Images 6 - 10**).

The AIRY ED100 performed incredibly well, and both histograms showed similar curves with all three prime colors separated with good strong peaks. In hindsight, the Canon's excellent glass provided a perfect benchmark against which to measure the AIRY ED100.

When inspected close in, very little evidence of chromatic aberration was noticeable in the AIRY ED100 in full daylight. The images produced are as sharp as the Canon lens – so sharp, you could probably take an image of someone's credit card from 10 miles away and still read it, you know, to finance more accessories to attach to your already overweight behemoth.

But that's not what you want to do with your telescope. No! You want to see tiny bright dots against a black background. Interestingly, that's where refractors shine. When compared to a

Image 12 - North America Nebula.

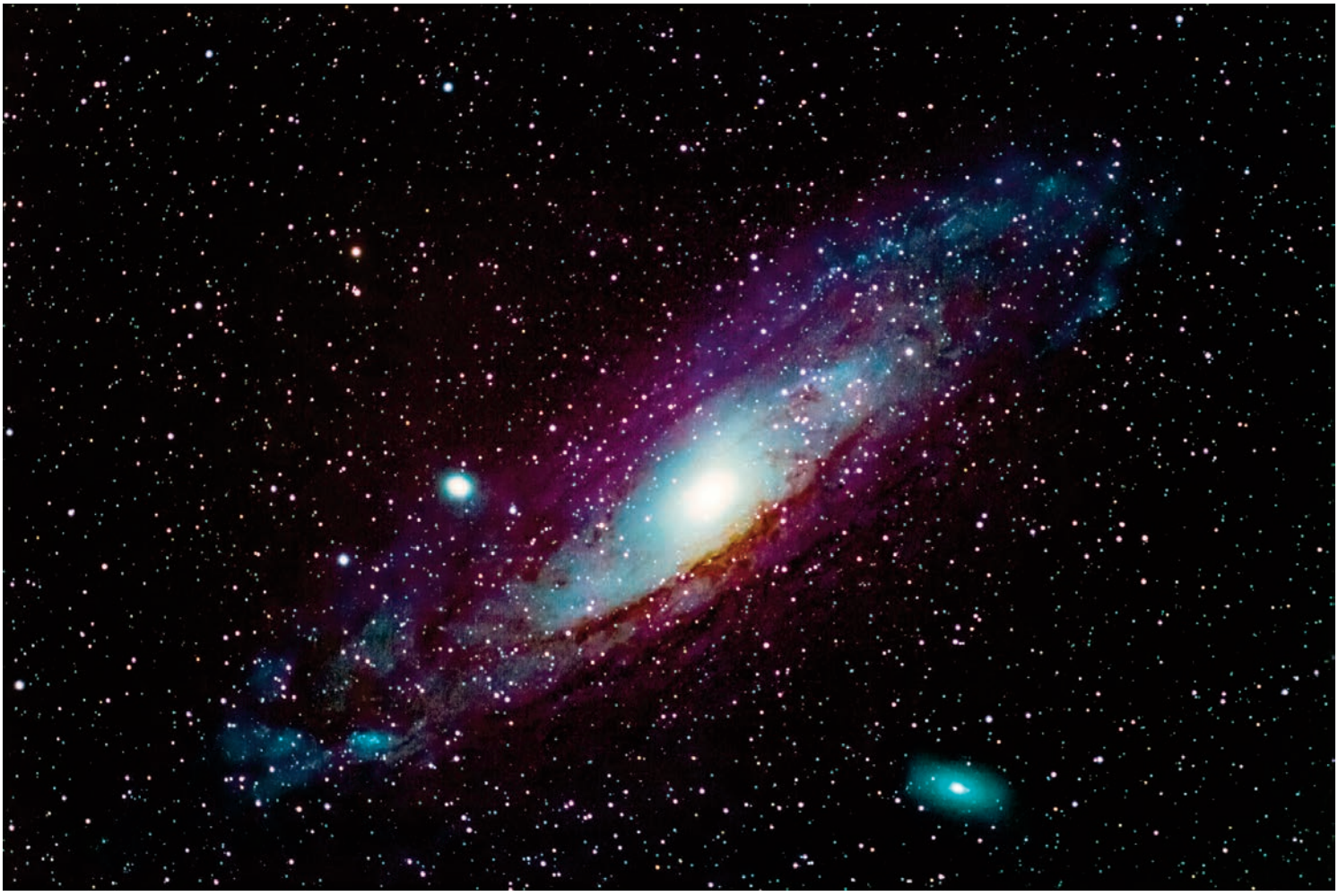

Image 13 - Andromeda Galaxy.

reflector telescope, refractors make the skies feel more organic – that smooth, glossy feeling like you're looking through glass. Definition between star and background is so well displayed when looking through an eyepiece, you'd be forgiven for worrying that the scope is focusing cosmic rays into your retina and turning you into the subject of the next Incredible Hulk movie. Cloudy nebulae glow with excitement with just a slight hint of color.

Does the AIRY ED100 truly deliver its promise to mesmerize you with life-changing moments? In manner of speaking, it does. However, where this scope begins to fail is when observing bright objects with higher powered eyepieces. We tried a 40-mm, 18-mm and a 7-mm. The 7-mm eyepiece seemed to represent the tipping point, exaggerating color shift when compared to the best triplet apos. But let's face it, high-magnification visual observing of planets is not why you buy a fast refractor, so that bit of chromatic aberration is hardly worth mentioning. Where the AIRY ED100 excels is in vast views of the night sky. One can always tell when looking through glass versus a mirror, and this

Image 14 - Eagle Nebula.

scope certainly doesn't disappoint when set up properly for wide-field visual work.

So, what happens when you attach your camera to that life-squeezing 2-inch OnAxisLock? Consider **Images 11 - 14**. The results speak for themselves.

Final Thoughts

How does the AIRY ED100 measure up? Overall, I would be quite happy to own one. The optics are extremely good, and its size and portability are brilliant – you can carry it in your arms like Paris Hilton clutching her beloved pooch.

The design and finish of the AIRY ED100 feel like quality, and you just cannot help but admire the orange-peel surface, which doubles up as grip to make sure you have a firm hand around it. The smooth red accents lend themselves to a well-tailored suit. The mechanics of the focuser are good and smooth – a little stiff on the knobs, but that stiffness helps to nail that fine focus without over shooting the mark.

As I say, the images its optics produce speak volumes. Stars are pinpoints in the night sky. In fact, the AIRY ED100 performs so well that it can be difficult to work out which star is which when doing an alignment process. Even though this is a doublet, it still gives fine results with relatively low chromatic aberration, and while most astrophotographers would consider the field flattener a must, the AIRY ED100 can produce acceptable results without it. ATT

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History Is Slipping Away

Another Tale of Saving Astronomy Technology of Yesterday

By Dave Komar and Tore Engen

During the last thirty years, we have seen an enormous development in the astronomical equipment used by amateurs. This includes CCDs, APOs, short-focal length refractors, go-to, autofocus, autoguiding technology, and the use of computers and handheld devices in all aspects of the hobby. These developments followed what many will say was the golden age of astronomy in the late 1950s and 1960s, which started with the space age and stirred interest in astronomy. During that period, there was a significant growth in small suppliers of astronomical equipment that are now long gone.

Unitron, Cave, Coulter, Tasco, and Royal Astro are all examples of companies whose histories are fading. The individuals behind these often family-owned companies have passed on, and their history and products that meant so much to thousands of amateur astronomers is slipping into oblivion.

The good news is that there are many dedicated individuals restoring the telescopes and working to preserve the history of that era. Thanks to their dedicated efforts, there is hope that the history will be preserved.

The Unitron History Project

An example of the efforts to preserve the history of a once prominent brand is the Unitron History Project, started by Dave Komar. The Unitron brand of telescopes was marketed in the United States and produced by Nihon Seiko, a Japanese company, from the late 1950s to the early 1990s. Unitron refractors were known for their long-focal lengths, white tubes, good optics, great design, high quality, but also relatively high cost.

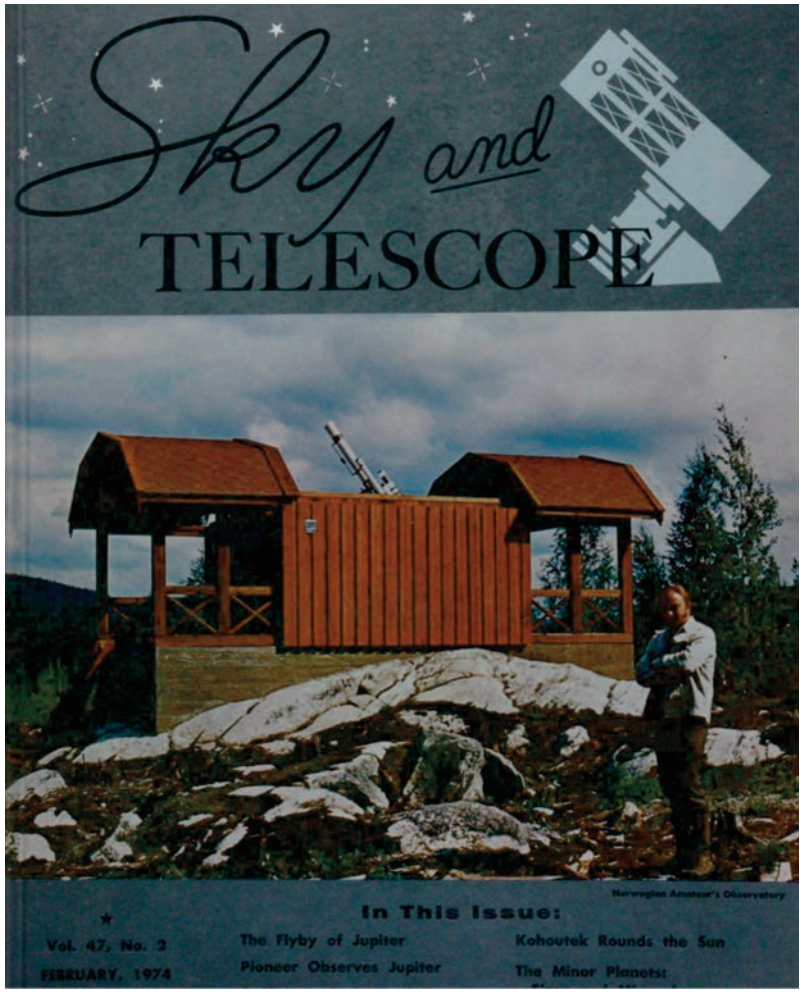

Image 1 – Carsten Deberitz and his Sky High Observatory in southern Norway on the cover of the February 1974 issue of Sky & Telescope.

Image 2 – The Sky High Observatory is a two-hour drive northeast of Oslo and located in the deep Norwegian forests.

Image 3 – Tore Engen standing in the same place in which Carsten Deberitz posed for the S&T photo – 40 years later.

Unitron's full-page ads could be found in every *Sky & Telescope* magazine in the 60s and 70s. they were the dream telescope for many amateurs growing up in those decades.

A primary objective for the project is research and documentation of a comprehensive and verifiable history of the U.S.-based Unitron Company, beginning with the supplier company, Nihon Seiko, and continuing until the 1990s. The second objective is to document the status of the rare 5-inch and 6-inch models.

Since introducing the project in September, 2014, the classic-telescope community has benefited from the information shared via the website http://www.unitronhistory.com , created by Unitron and Polarex (the European name for Unitron) enthusiasts from Australia, Belgium, Canada, Denmark, Greece, Italy, Japan, Netherlands, Norway, as well as from all over the United States.

So far, the project has documented much of the history and discovered the locations of many of the larger-aperture Unitron and Polarex models. Very often, the

Image 4 – Carsten Deberitz' vintage refractor as rediscovered.

Image 5 – The vintage refractor disassembled for transport.

history and instruments are preserved based on a few individuals' tireless efforts, and some coincidences and luck. One example of such preservation of Unitron history is the story of the Sky High Observatory in Norway, which was featured on the front page of the February 1974 issue of *Sky & Telescope*.

Sky High Observatory

Sky High Observatory in southern Norway was built by Carsten Deberitz in the early 1970s. The cover photo of Sky & Telescope (**Image 1**) shows the observatory, with Carsten standing proudly in front of it. Carsten was born in 1945 and passed away in 2006. He and his wife Grete were leading figures in the Norwegian Astronomical Society for many years.

The observatory was featured in many Norwegian newspaper articles in the 1970s and early 1980s. It was equipped with a 5-inch Polarex refractor for astrophotography and H-alpha solar observations. Among amateurs, Cartens's observatory and 5-inch refractor were very advanced in the 1970s.

Tore Engen is another Norwegian amateur astronomer now living in Oslo, who has been interested in astronomy since the mid-1960s. He was 15 years old when Carsten was featured in that issue of *Sky & Telescope* magazine, and at the time owned a 3-inch Polarex equatorial refractor, which he later sold. Exactly 40 years after the Sky High article in *S&T*, in February 2014, Tore started thinking about a sales ad of a 3-inch Unitron he had seen in an old issue of the Norwegian astronomy magazine, *Astronomi*. When he discovered it was still for sale, he purchased it.

That purchase reminded him of Carsten and his observatory. Tore had only

Image 6 – Carrying each component down the hill.

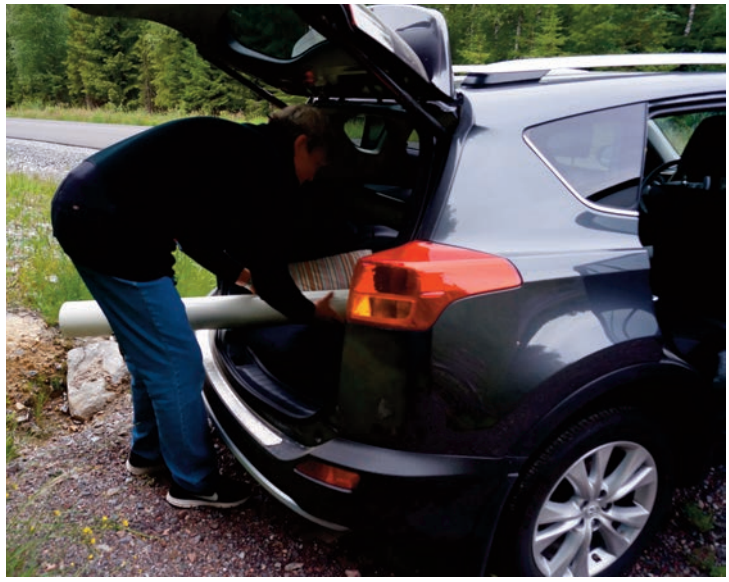

Image 7 – Transport of the equipment to Oslo took two trips.

Image 8 –Everything in the observatory will be treated to careful restoration.

met Carsten briefly in the early 70s – they lived in different parts of the country, and with the age difference, they had no contact.

In May 2014, Tore began a search to determine what happened to the Sky High observatory and the 5-inch telescope. Tore had a friend, Helge-Ivar Magnussen, who back in the 1970s had an observing platform at the observatory, equipped with probably the first orange-tube Celestron 8-inch SCT in Norway. Helge-Ivar had not been at the observatory in 30 years, but they concluded that they might be able to locate it. The area with the observatory is a two-hour drive northeast of Oslo and located in the deep Norwegian forests (**Image 2**).

With the growth, the landscape had changed a lot in 30 years, so Helge-Ivar was unable to recognize where they should start venturing into the forest, but they got a lead from some locals on where to start the search. At their suggested place, they parked and started walking into the woods. They expected the observatory to be near the road, but the vegetation was thick. After a bit more walking, though, they eventually spotted the observatory between the trees.

The building was in bad shape, but it was still standing thanks to the inside brick walls. The planks had started falling off, and the brick walls inside were visible in many places. The two observing platforms were rotting away, but the piers where standing. It is incredible how fast nature takes over again. **Image 3** shows Tore standing in the same place that Carsten posed – 40 years later.

They had no idea if the telescope was still inside, and it was impossible to see by eye into the building, so Tore pressed a camera into the building's few small openings and took flash photos. In one picture, they could see something white, so concluded that the telescope was still in there.

They could, of course, not break in, so they left, but at least they had found the observatory. Then, they noticed a house on the other side of the road about 100 meters from their car, and Helge-Ivar recognized a

Image 9 – After careful inspection of all components, Tore's biggest concern was for the optics.

person standing outside. It turned out, Carsten's son and widow lived there. From them, they learned that the observatory had not been in use for decades.

Tore and Helge-Ivar were granted access to the building. Back at the observatory, they opened the door, and it looked exactly like in the *S&T* article from 40 years ago. For these astronomy enthusiasts, the discovery could not have been more exciting had they opened Tutankhamen's tomb.

They inspected the telescopes and mounting carefully – a lot of dust and dead insects, of course, but the observatory seemed dry inside. The first on-site inspection revealed that the condition of the telescope was surprisingly good. One thing that also got their attention was the bulletin board on the wall with some messages. The most recent was from 1986 …

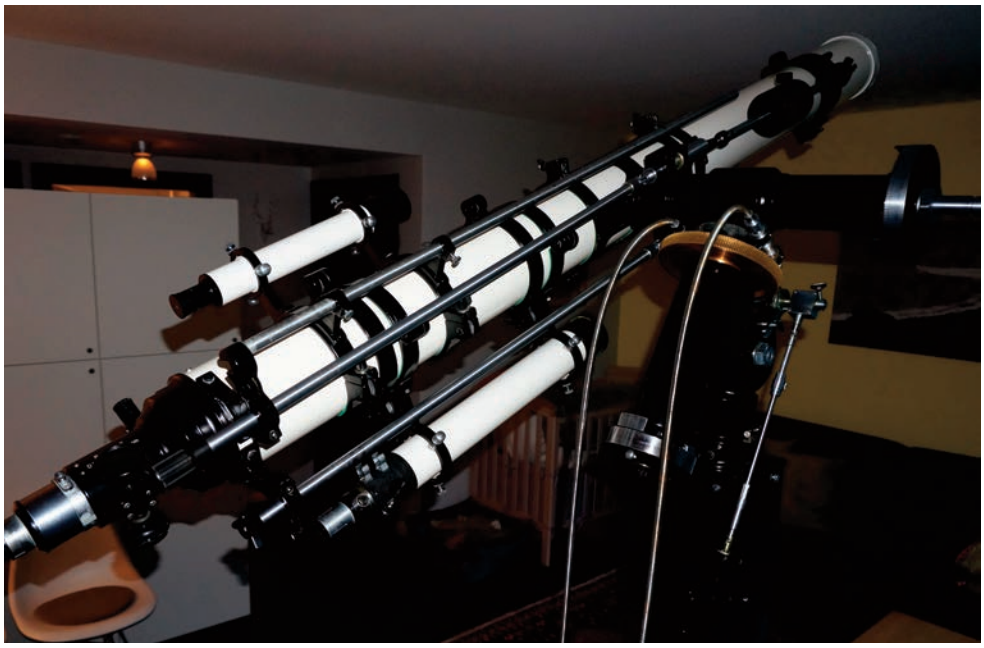

Image 10 – The vintage mount functions perfectly.

Image 11 – Cleaned up and fully restored, the vintage refractor awaits its next observatory.

28 years ago!

Needless to say, after very little thought, Tore negotiated the purchase of the equipment. The dismantling and transport back to Oslo took two trips. The transport went without incident, but the pier and mounting were heavy, and made even more so given that they were unable to separate the equatorial mount from the pier due to some broken bolts – they had to carry it as one piece down to the road.

Back home, when Tore cleaned away the dirt, it looked like the scope was in good condition – not like new, but considering the age, it was very good. His biggest concern was the optics (**Image 9**).

The 5-inch lens had a lens cap, but when they took the tube off the mounting, it turned out that the lens cap was the one used during stop-down solar observation. The lens had been open to the outside air for many years, and looked dirtier than the worst barn window you could imagine. However, the open lens cap probably enabled the lens to dry. Twenty-five years of temperature variations between +25 and -30 degrees Centigrade can produce a lot of moisture and fungus. Cleaning the optics went without any incidents. There was no fungus between the elements. All the finders (75-mm, 60-mm and a 45-mm) had lens caps, but the 75-mm does have a little fungus between the front elements.

Regarding the mounting (**Image 10**), it seems to move freely. The only thing Tore had to do was to clean and lubricate the RA gears. So the telescope is "restored" back to working order.

Unfortunately, where Tore lives, it is not possible to set up an observatory. So, for the time being, this beautiful telescope sits in his basement (**Image 11**). It should be in regular use, but as long as that is not possible, it is at least saved from the elements. To Tore, this telescope is the "Holy Grail," so at the moment, he is just happy just to have it in the basement, even if his wife dos not totally agree.

What can you do?

Preserving the history and instruments of yesteryears is a joint effort among hundreds, maybe thousands of dedicated amateurs worldwide. The internet is an important resource in documenting and sharing the history and information about classic telescopes. The Cloudy Nights Classic Telescope Forum (http://www.cloudynights.com/forum/62-classic-telescopes/) is a good example, and one of the primary meeting places for those dedicated individuals. There you can share your stories, photos and experience in restoring vintage telescopes. ATT

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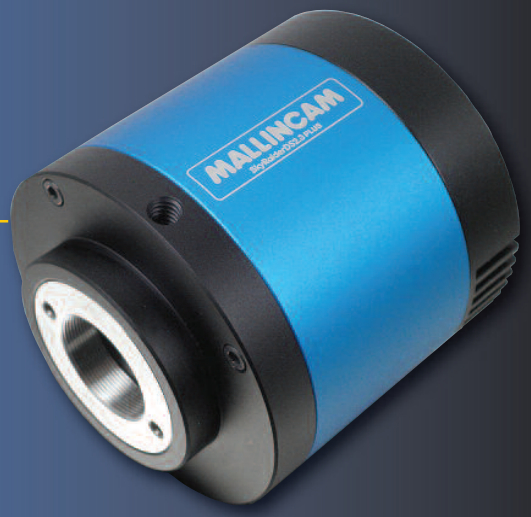

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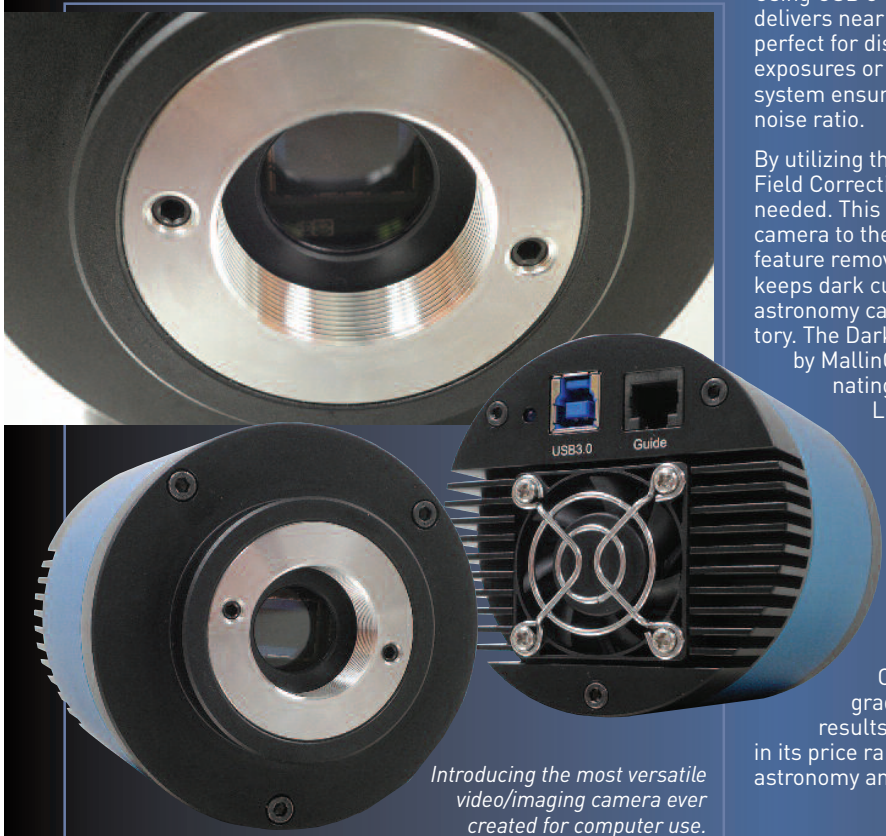

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Telescope Support Systems

Crafting Custom Solutions to Extreme One-Off Telescope Support Challenges

By Gary Parkerson

Image 1 - The Surly Big makes its astro-lab debut at NEAF 2016 with a hardwood dowel and block supporting a Sky-Watcher Star Adventurer mount carrying a DayStar refractor and DayStar Quark, which solution required removing the bike's seat. It was also way too shaky!

Telescope Support Systems' website describes the company as, "*… founded by a pair of guys who live and breathe astrophotography. Between us, we have over 40 years of experience. While we currently shoot with CCDs and DSLRs, a peek in our storage lockers will reveal film and film cameras, hypering tanks, cold cameras and a slew of 'stuff' to aid in astrophotography. Over the years, we have both come to realize that eliminating differential flexure is one of the hardest things to get right (after getting proper focus). Having access to state of the art CNC-machining equipment made it an easy decision to start designing our own support equipment. This let us see what works and what does not. Over the last few years, we have*

Image 2 - TSS's much improved remedy met the Big for the first time while at DayStar's Warrensburg, Missouri headquarters. The TSS system is comprised of five components: (1) a base, (2) a pivot block, (3) a riser, (4) a dovetail saddle and (5) a short Vixen-format dovetail rail.

developed a system of tube rings and supports that are designed to be robust, lightweight and work extremely well. This is what we offer to you, our fellow astrophotographers."

TSS's product lines have grown quickly and now include exquisite camera mounts, clamp blocks, dovetail plates, guide rings, telescope rings, saddle plates, scope tails, and even a housing for all-sky cameras … none of which are covered in this article. What is covered is an example of something about which their website remains essentially silent: Custom telescope support solutions.

As I write this, I'm six months and 4500 miles into a 48-state bicycle journey, carrying astro tech around the country with which to share views of the Sun with everyone I encounter along the way. There's a total eclipse of the Sun coming, and this is how I've chosen to celebrate that greatest-in-my-lifetime astronomical event.

I ride a cargo bicycle by Surly Bikes, and I first demonstrated it in full mobile astro-lab mode at NEAF 2016 (**Image 1**). The configuration I came up with required that I remove the bike's seat post and replace it with a hardwood dowel topped by a hardwood block onto which I fastened one of Sky-Watcher USA's Star Adventurer micro-German equatorial mounts, which in turn supports a refractor equipped with a DayStar Quark.

Image 3 - The TSS solution is not only rock solid, but it places the eyepiece at a kid friendly height.

So far, I've used three refractors with this set up: one of DayStar's 80-mm achros, a Stellarvue SV70T apo, and a Explore Scientific's carbon-fiber ES80EDTCF apos. At around five pounds, the SV70T and ES80EDTCF are both svelte, as high-end apos go, but they were still too much for the hardwood dowel to support when combined with the mount, Quark and an eyepiece. But I had no better solution, so was resolved to simply suffer through with the shaky setup … until the two fellows from TSS stopped by *ATT's* NEAF exhibit.

They're kind, those two guys, so they didn't blurt the obvious weaknesses of my make-shift design. Instead, they congratulated me on a novel setup, and then set about quietly planning an improvement. The long and short of their reaction was, "We think we could do a little better. Do you mind if we take a few measurements?"

A couple of months later, I received a package from TSS care of a bike shop in Jefferson City, Missouri. I didn't get to install the device they had created until I visited DayStar's Warrensburg, Missouri headquarters, though, because I managed to lose a couple of critical screws the TSS team had included. The DayStar team replaced the lost fasteners from their ample manufacturing supply, and I first installed the assembly in the DayStar parking lot, as shown in **Image 2**.

I describe the custom TSS solution as an assembly, because it is. It is comprised of five main components: (1) a base, (2) a pivot block, (3) a riser, (4) a dovetail saddle and (5) a short Vixen-format dovetail.

The base of the assembly bolts/clamps onto the Big's overlong frame between the seat post and its rear cargo area, and never leaves the bike. There's a through hole on the front of the base through which a stainless-steel cap screw finds a standard threaded insert in the frame. The rear of the base is secured to frame by a clamp bar held by two cap screws.

Having gotten to know the TSS guys well over the years, I should not have been surprised that the base fit the frame so perfectly, but I was. After all, they only had minutes to take measurements at NEAF and have not seen the bike since, so were denied any trial-and-error wiggle room in designing this component. Yet, fit precisely it did.

The pivot block allows me to level the mount, even when the Big is set up on uneven ground. A single large stainless-steel cap screw squeezes the two sides of the pivot block against the top of the base member. I simply adjust the mount to level, then retighten the large

Image 4 - The icing on the cake was when we realized that the TSS guys had not only planned for accommodating kids, but for wheelchair-bound guests as well!

cap screw.

The riser elevates the mount above the bike seat, allowing it to track without interference, and it was the screws that fasten the riser to the pivot block that I managed to lose at the bike shop in Jefferson City.

The riser is topped by an equally-custom dovetail saddle, which simply clamps the short dovetail in place with two thumb screws. The dovetail fastens, in turn, to the bottom of the little Sky-Watcher Star Adventurer mount with a single captive 1/4-20 socket screw.

The resulting mounting system is much more rigid than my original hardwood-dowel-and-block solution, and I'm no longer required to remove the bike seat before I can attach the mount and scope, which is a huge convenience.

But that's not all the TSS guys planned into the system. I did not realize it when I first set the assembly up, but the guys calculated the mount height to not only be tall enough to clear the bike seat, and just low enough to be within reach not only of school age children (**Image 3**), but also to be within reach of those who must view from wheelchairs (**Image 4**). And I've got to say, I've never been prouder of a couple of fellow astronomy nerds than when we made that latter discovery.

The point of all this isn't that you should buy a bike and have TSS build a telescope support for yours, too. Heaven forbid! The Big is already one bicycle astro lab too many! My point is simply this: I did not know what I needed, but I knew the fellows at TSS well enough to trust that they would figure it out. And they did. A couple of photos and a few measurements taken amid the chaos of the busy NEAF expo floor were all they required. Well, that and a lifetime of experience at astronomy, high-precision machining and component design.

My telescope-support application was ridiculously one-off, but the TSS duo still made solving the challenge look easy, and the components they created look great. So, the next time you find yourself perplexed by your own novel telescope-support challenge, save yourself the stress. Contact the guys at TSS. You'll be glad you did. ATT

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LOOKING BACK SERIES

LUNT SOLAR SYSTEM LS152

Editor's Note by Gary Parkerson:

Astro tech dedicated to solar observing and imaging will increasingly dominate ATT's pages as the August 21, 2017, solar eclipse nears. Witness that this issue includes coverage of two Lunt Solar Systems dedicated solar products. Stephen Ramsden's and Brian Stephens' coverage of the LS152THa touches on white-light vs Hydrogen-alpha vs Calcium K bands, because that modular solar platform is capable of all three of the most popular observing and imaging modes, making this revisit of their article especially timely.

Lunt Solar System LS152

Modular Design, Ease of Use and Cutting Edge Technology

By Stephen W. Ramsden and Brian Stephens

The last decade has seen an amazing upsurge in the amateur solar astronomy market. David Lunt's revolutionary design work at Coronado set the stage for the industry to go from the realm of the university scientist to that of the average consumer. David's son, Andy Lunt, has taken the hobby to extremes of technology and styling that his father could never have imagined and made it even more available to the amateur around the world. Lunt Solar Systems seems to add something new almost monthly to their extensive lineup of available solar telescopes and filters.

The LS152THa/CaK/Solar wedge setup is an extraordinary all in one solution to the amateur appetite for high resolution narrowband solar viewing and imaging.

The LS152 system is basically an f/6, 900-mm focal length, 152-mm achromatic refractor designed to allow for the use of all three popular types of amateur astronomy. It has a modular design which allows for the insertion of either a H-alpha module using an internal single etalon (<.7A) or double-stacked (<.5A) internal etalons, a choice of three sizes of Calcium K line (393nm) filters with removable energy-rejection filter, or a 2-inch white light Lunt solar Wedge. The scope can even be used as a high-quality night sky observing instrument by replacing the solar wedge with a standard diagonal. This scope could very well be the only thing you need to enjoy solar or conventional night astronomy in one package!

Hydrogen Alpha

Using the LS152 in the Hydrogen Alpha mode is as easy as 1,2,3. The scope is housed in a sturdy golf-bag style hard-shell case or aluminum sided hard-shell

Image 1 - Lunt LS152 pictured above (right) with Coronado 90 mm DS and Explore Scientific 127 mm in background for size comparison.

case which will hold all the modules as well as a couple of eyepieces.

Simply insert the red H-alpha module into the rear of the refractor and put in a Lunt Zoom eyepiece and you are ready to go. The views are breathtaking through this instrument in either the single- or double-etalon modes. There is a thin line of reddish gray spicules on the edge of the H-alpha Sun which took my breath away upon my first use of this scope. I had never seen them visually before in any of my other H-alpha big guns. The ample aperture of this system allowed these spicules to jump out at me the very first time I looked.

The included pressure-tuned etalon is a remarkable leap forward in solar scope technology. With this system the etalon never moves, tilts, or flexes, causing the dreaded sweet spot in so many competitors. The entire etalon is housed in an airtight barometric chamber and uses changes in air pressure (+/- 3 p.s.i.) to change the refractive index of the air between the etalon surfaces. The control for the pressure tuning is a motorcycle throttle style grip that equals its functionality with a smooth and innovative styling. The precise tuning and even illumination produced by this Doppler true tuning design is an exclusive feature on the Lunt Solar Systems scopes.

The H-alpha module is equipped

with a 2-inch top-of-the-line Feather Touch focuser. You can insert any of the available H-alpha blocking filters (6-mm–34-mm) into this focuser and have plenty of in focus and back focus. I am able to focus any of my cameras, binoviewers or eyepieces easily with room to spare using this innovative design.

Calcium K

Now the fun part! To switch to either the CaK or Solar Wedge mode, simply loosen the three thumbscrews at the rear of the refractor and the entire H-alpha assembly slides out easily, allowing for insertion of the Calcium K/Solar Wedge module. The CaK module comes with its own stock Crayford 10:1 focuser and also has an available Feather Touch focuser. Just like with the H-alpha mode, you choose the size CaK filter that you want to use (12 mm–34 mm) and simply insert it into the module. Then you slide the entire module into the scope and tighten the three thumbscrews. Just like that you have transformed your top-of-the-line H-alpha scope into a large aperture Calcium K scope on the fly without ever removing it from the mount…simply amazing if you ask me.

White-Light Solar Wedge

So, if that wasn't enough Andy and Brian over at Lunt Solar Systems decided to make it a white-light/Solar Wedge scope as well. Remove the CaK diagonal from the focuser and insert the 2-inch Lunt Solar Wedge into it and you now have a fantastic high-resolution setup for viewing white-light features like sunspots, faculae, and granulation. Remember, we still haven't removed the scope from the mount or torn down anything to set up a different scope. This is all using the same base refractor!

One more thing…simply remove the wedge from the focuser and insert a standard diagonal and you know have very respectable f/6 night sky refractor. Thought I'd throw that in there just in case you were wondering.

Image 2 - LS152 shown in H-alpha mode with B1800 blocking filter on CGEM mount.

Another neat feature of this well-thought-out design is that there is no need to ever try and find the Sun by looking directly at it. The solar finder required on so many other offerings in this market is unnecessary on this scope as it

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Image 3 - LS152mm scope in the with the CaK/white light module inserted.

Image 4 – Set up as a white light/Solar Wedge scope.

has, as a result of its incredible design, a built-in solar finder right on the mounting rings. All you have to do is look in the reverse direction down the tube and wait until the forward rings shadow is aligned with the aft rings surface and you have a perfectly aligned solar scope without any need for adjusting the finder… ever.

I have been using the LS152 extensively in my imaging and outreach for close to a year now and I can tell you it is a marvel to see and use. It is a monstrous scope when compared to my others and always gets all the ooohs and ahhhs from participants.

When the scope is torn down and packed up it fits neatly into either case and is only moderately heavy and very easy to transport with the included wheels on the golf-cart-style case. If you have carried around big Schmidts for years like me, this one is as light as a feather in comparison.

Thank you for reading and I certainly hope that all of you get a chance to look through this marvelous scope! ATT

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