SkyWAAtch

An Oft-Overlooked Gem

Courtesy of Olivier Prache is this impressive photo of M12, one of the nearly two dozen globular clusters in Ophiuchus. Olivier used his 12.5” Hyperion astrograph and ML160803 camera to capture this image (9 hours of exposure; processed with PixInsight).

M12 resides at a distance of about 18,000 light years. It has a diameter of 75 light years and lies about 3 degrees in the sky from Messier 10, a slightly brighter globular cluster in Ophiuchus.

In This Issue . . .

Events for July

Upcoming WAA Lectures

Leinhard Lecture Hall,
Pace University, Pleasantville, NY

There will be no lectures for the months of July and August. Lectures resume on September 8th with Member Presentations Night.

Starway to Heaven

Saturday July 15th, Dusk.
Ward Pound Ridge Reservation,
Cross River, NY

This is our scheduled Starway to Heaven observing date for July, weather permitting. Free and open to the public. The rain/cloud date is July 22nd. **Important Note**: By attending our star parties you are subject to our rules and expectations as described here. Directions and Map.

New Members. . .

Jose Ortiz and Rose Edwards - North Salem
Arun Agarwal - Chappaqua
Moses Zhang - Armonk
Daniel Rosenthal - New York
Melanie Millard - White Plains

Renewing Members. . .

Erik & Eva Andersen - Croton-on-Hudson
Arthur Linker - Scarsdale
William Newell - Mt. Vernon
Ernest Wieting - Cortlandt Manor
Tom Crayns - Brooklyn
John Paladini - Mahopac
Roman Tytla - North Salem
Scott Rubin - Yorktown Heights

RAC SUMMER STAR PARTY
July 21st through July 30th

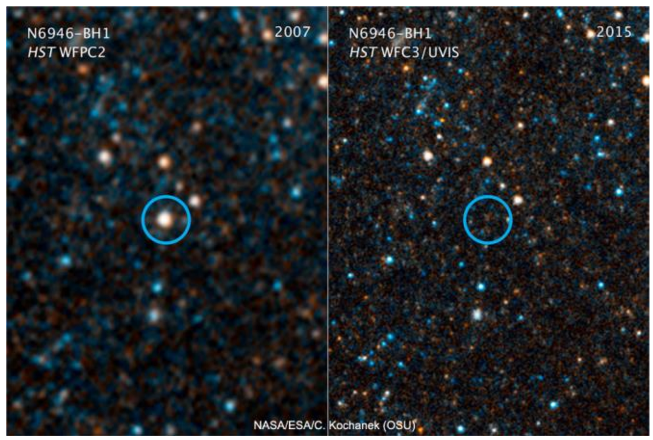
The Rockland Astronomy Club is sponsoring its summer star party July 21th through July 30th. RAC holds the longest and most exciting star party, geared to both the serious observer, imager, and the whole family. The location in the Berkshires is known for its pristine dark skies, and gorgeous arching Milky Way. Don't miss the Opening Festival and StarBQ with live music. For details go to:

http://www.rocklandastronomy.com/ssp.html.

Wanted Assistant Editor

The WAA newsletter (the *SkyWaatch*) is seeking an Assistant Editor. If you can help, please let us know. Your participation in editing, compositing and proofreading tasks or submitting articles or images, will be much appreciated. Email Tom at waa-newsletter@westchesterastronomers.org.

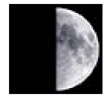
Call: 1-877-456-5778 (toll free) for announcements, weather cancellations, or questions. Also, don't forget to visit the WAA website.



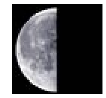
What's happened to giant star N6946-BH1? It was there just a few years ago -- Hubble imaged it. Now there's only a faint glow. What's curiouser, no bright supernova occurred -- although the star did brighten significantly for a few months. The leading theory is that, at about 25 times the mass of our Sun, N6946-BH1's great gravity held much of the star together during its final tumultuous death throes, after which most of the star sank into a black hole of its own making. If so, then some of what remained outside of the black hole likely then formed an accretion disk that emits comparatively faint infrared light as it swirls around, before falling in. If this mode of star death is confirmed with other stars, it gives direct evidence that a very massive star can end its life with a whimper rather than a bang.

Credit: APOD
Image Credit: NASA, ESA, Hubble, C. Kochanek (OSU)

ALMANAC
For July 2017 by Bob Kelly


Jul 1


Jul 9


Jul 16


Jul 23

My grandchild Fiona loves zipping down slides; the steeper the slide, the greater the fun and more laughter. The ecliptic in our skies this month is like a shallow slide – so the planets just don't get very high in the sky, and, in the morning sky, they hug the horizon like they are afraid they might fall off the slide.

Catch Jupiter early in the evening, as it's dipping lower in the southwestern skies after sunset. The banded body sets by 1am early in July and by 10pm later in the month. Jupiter is still the planet that gives your scope the most to see, even at smaller apertures, but Saturn is a close second. I suggest, especially for newcomers, to take three good looks at Jupiter. First, get your eye focused on the bright orb itself. The second look is for the tiny dots of the Galilean moons nearby. Stop and think about what Galileo may have thought on his first views of these dots and all the trouble that followed. Be glad you can see them through a much better telescope than Galileo's then state of the art scope. Then, third, look at the bands on the planet itself. Further looks at higher power may reveal details in the cloud bands or the differences among the moons.

Just a month after opposition, Saturn's only a few million miles further away and fractions of an arc second smaller than last month. It's highest on the daily slide by late evening, making a splendid appearance in telescopes. As always, with Saturn, look at the rings – tipped almost 27 degrees toward us, it's our best chance to see the subtle differences in shading between the A (outside) and B (inside) portions of the rings. The brightness of the wide-open rings make it harder to see Saturn's moons, and Titan, at magnitude plus 8.4, is not as easy to catch as Jupiter's big four but is regularly seen in most scopes. My favorite, Iapetus, is south of Saturn around July 5th, moving westward. By the 26th, Iapetus is furthest out from Saturn, ahead of the planet by 9 arc minutes and brightening to magnitude plus 10.2, in the range of most of our telescopes

Morning darkness makes a noticeable return, more so than in the evening, since the earliest morning twilight happened back in early June. That'll make it a bit easier to get up to see the morning scenes later in the month.

Venus is low, but soooo bright as usual. It makes its earliest rising of the year, just before 3am Daylight Time. Mercury makes its latest setting of the year, just after 9:30pm Daylight Time. Of course, these records are made possible by the early sunrises and late sunsets of our near-summer-solstice time of year.

Mercury doesn't get out of the evening twilight, so binoculars are recommended for viewing it low in the west. The first magnitude star Regulus slides by from the 23rd through the 26th, even harder to see in the scattered light from the Sun.

Early this month, Venus photo-bombs the Hyades cluster. On the 12th, Venus gives the Bull a second 'eye' across the 'V' from Aldebaran. Can you photograph dazzling Venus AND the stars of the Hyades? On the 27th, Venus is an ornament on the tip of the Bull's horn. For the longest time, I thought the Hyades were the Bull's horns. The extensions of the 'V' are harder to see in our light-polluted skies. The crescent Moon pops into this scene on the 19th and 20th.

The most interesting evenings for Jupiter and its moons transiting the planet and popping in and out of Jupiter's shadows happen on the 5th, 12th, 19th, 21st and 28th. For Saturn, Titan is out ahead of Saturn (to its west) on the 5th and 21st and following Saturn on the 13th and 29th. Our Moon stalks Saturn on the 6th.

The Moon passes in front of star gamma in Libra shortly before 11pm ET on the 31st. The dark limb of a just-past-first quarter Moon makes the plus 3.9 magnitude star disappear while they travel together low in the south-southwestern sky.

If you are looking for meteors (or just looking and see meteors), the Perseid meteors contribute a few to our skies, starting in mid-July. The showers that peak in July are pretty weak for us – the Southern Delta Aquariids are, well, a southern hemisphere shower, with a good number of faint meteors down under, but here, not so much. The Alpha Capricornids average five an hour in late July, but some can be bright fireballs.

The International Space Station will be visible in the morning sky starting on the 5th through the 25th and in the evening starting the 22nd. The most number of overflights in a night are six on the 24th/25th.

An Astronomy Trip to Chile: Part 3 – Cerro Tololo Inter-American Observatory

Larry Faltz

The first two parts of this series are in the May and June 2017 issues of SkyWAAtch.

We left our hotel in Vicuña at 9 am in our big tour bus for the drive to the Cerro Tololo Inter-American Observatory (CTIO), located only 11 miles as the crow flies from the town. The access road to the observatory begins just south of the paved *Ruta de Estrellas*. It's a well-graded dirt road with many inclines and switchbacks, and the trip from the entrance gate to the observatory took over an hour. The dry mountains are home to a few drought-tolerant plants. There are rare green bushes at the bottom of dry river beds or run-off gullies, but we're in the southern part of the Atacama Desert and the same conditions that we found at La Silla are present here. Just 5.7 km from Cerro Tololo, the road splits. A left turn takes you to the observatory, while a right turn takes you on another graded road 14 km to Gemini South on Cerro Pachón. We stopped at the intersection, where a stone observing deck looked out over the mountains and across to the Gemini and SOAR telescopes 4 miles to the southeast and 3,000 feet above. A plaque dedicated the expansive view to Dr. Sidney Wolff. Now retired, she directed the National Optical Astronomy Observatory (NOAO) from 1987 to 2000 and had been Director of Gemini and President of the SOAR and LSST Corporations.

Sidney Wolff, PhD

On the road to Cerro Tololo, with Cerro Pachón and the domes of Gemini South and SOAR on the far mountain.

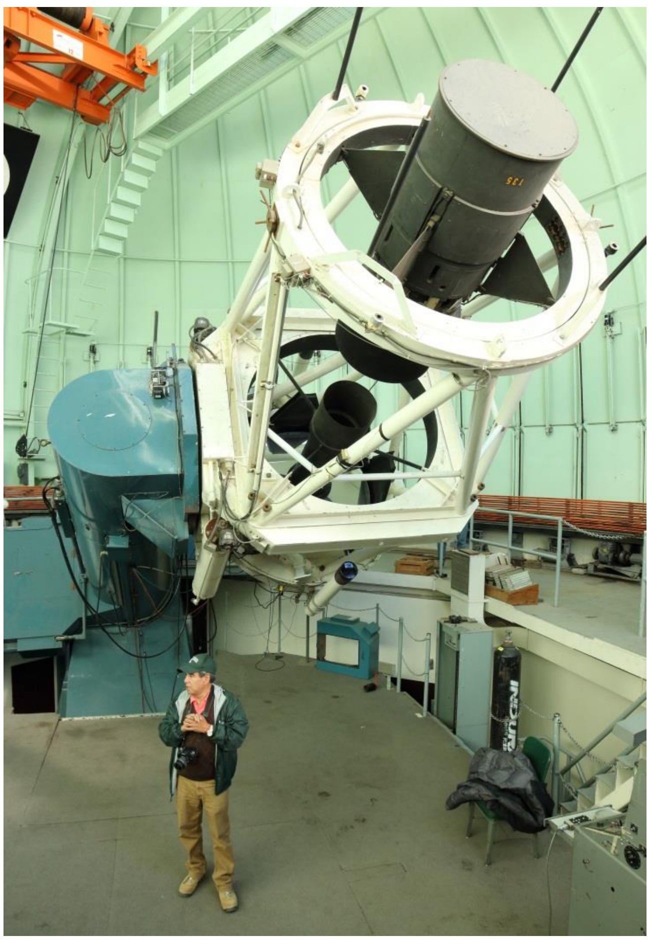
Cerro Tololo is operated by the NOAO, which also operates Kitt Peak National Observatory outside of Tucson, Arizona. NOAO itself is operated by the Association of Universities for Research in Astronomy (AURA) under a cooperative agreement with the National Science Foundation. AURA members include 34 U.S. institutions and 6 international affiliates. This somewhat Byzantine organizational structure reflects the necessary complexities and expense of cutting-edge astronomical research.

Although the observatory is closer to Vicuña, Cerro Tololo's administrative offices are in La Serena, a much larger city with a university and close proximity to the airport (and a 14,000-seat soccer stadium). The telescopes are located in the mountains south of the Elqui Valley, within an 85,000 acre tract of land called the Estancia El Totoral. The initial proposals for a large-scale Chilean observatory were floated by AURA and NOAO in 1960. In late 1962, after various site surveys and observational tests with a 0.41 meter telescope that was hauled up the mountain on mule back, the Cerro Tololo site was selected and purchase of the entire Estancia El Totoral was negotiated. The official history of Cerro Tololo mentions that to finalize the real estate transaction, policemen from Vicuña were dispatched to fetch the apparently ambivalent owner, one Señor Juan Orrego, to the closing.

The 4-meter telescope is housed in the silver dome. The 1.5 meter instrument is on the right and the 0.9 meter on the left

In 1964, the mountaintop, at 2200 meters (7,200 feet) elevation, was flattened and telescopes of 0.41 meters, 0.9 meters and 1.5 meters aperture were erected. In 1966, the Ford Foundation donated $5 million to begin fabrication of a 4-meter instrument almost identical to the telescope then planned for construction at Kitt Peak. The big telescope saw first light in 1975 and was named the Victor Blanco Telescope at a ceremony on the mountain in 1995 to honor the second director of CTIO. Blanco died in 2011. We were told that on the hundredth anniversary of his birth in 2018 his ashes will be interred at the observatory. The telescope was the largest instrument in the southern hemisphere until the VLT opened at Cerro Paranal in 1998.

We were met by Kadur Flores, our guide for the tour. After giving us a description of the observatory and some of its history, Kadur took us inside the dome of the 1.5-meter instrument. This Ritchey-Chrétien telescope is now part of the Small & Moderate Aperture Research Telescope System (SMARTS) consortium, a quartet of 1-meter class telescopes on Cerro Tololo operated by Yale University and Georgia State University, with membership open to other institutions and even to individuals who can purchase time on the instruments to do "citizen science" or be part of ongoing projects.

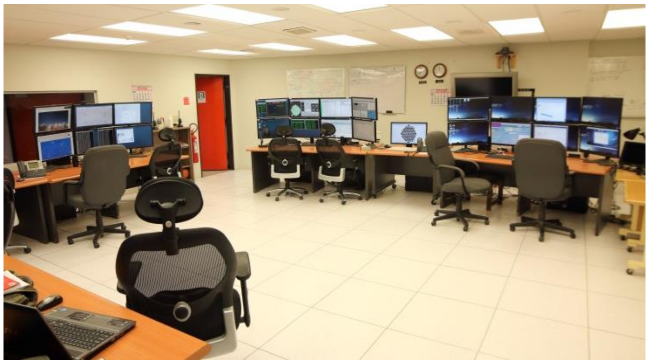


Kadur Flores and the 1.5 meter telescope.

The 1.5 meter instrument had been a galaxy hunter in the past but is no longer used for visual imaging. It is now fitted with CHIRON, an echelle spectrometer that measures precise radial velocities of individual stars. Kadur opened and closed the dome's shutters, slewed the telescope and even rotated the dome while slewing. The gallery under the dome is fixed to the observatory floor, so dome spun slowly and noisily behind us as the scope went through its gyrations, a slightly disorienting experience. When the shutters were open, the dome of the 4-meter scope next door was visible. As a result, a small area of the sky to the southeast is blocked from the 1.5's view. Users of the telescope need to take that obstruction into account when they plan their targets. We got a chance to examine the telescope up close. Like all research instruments, it has lots of wires, something that I, as a Mallincam video observer, always respect!

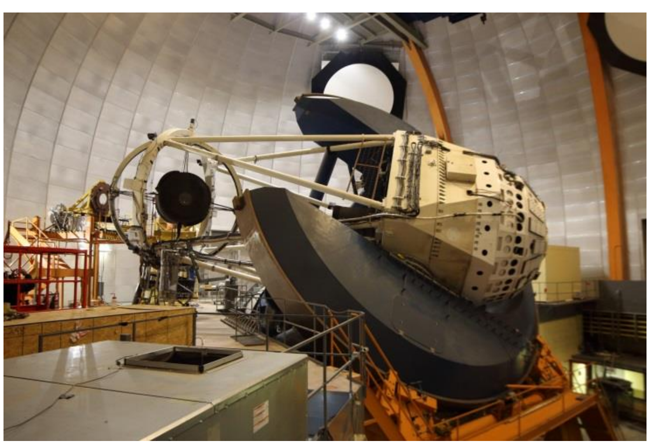
Phil and Karen Kelton (Austin, TX) under the primary of the 1.5 meter telescope

We walked over to the Victor Blanco 4-meter dome. We first visited the control room, a large bright space arrayed on three sides with computer workstations and video displays for telescope and instrument control, communications and weather. A pair of wall clocks displayed the time in Chile and Tucson, a reminder of the governance of the observatory. Surprisingly, these were analog clocks and the minute hands differed by 3 minutes, which I thought was kind of quaint for a setting in which so much precision is obligatory. One gets the impression that if they were allowed to show a difference no one, other than us, actually looks at them. We were careful not to touch anything. I resisted a powerful urge to reset the clocks.



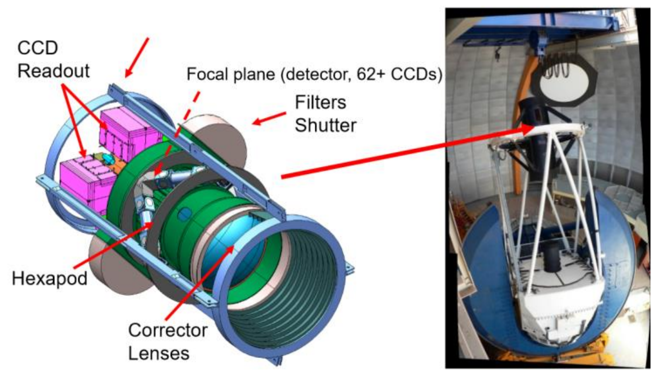
Control room of the Victor Blanco telescope

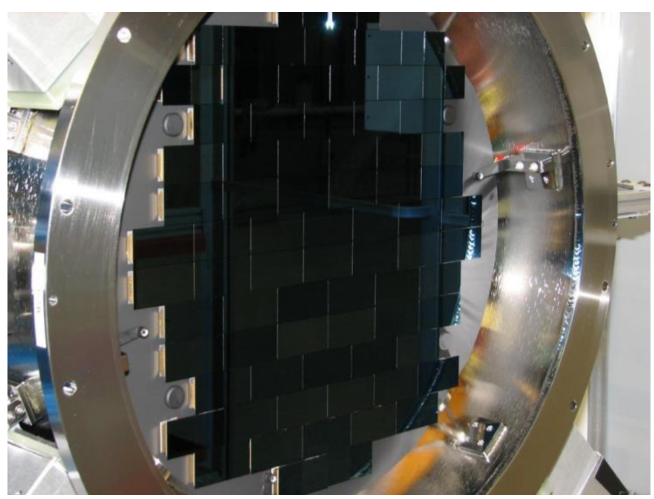
We took an elevator up to the telescope level and emerged into the bright, spacious dome. The enormous horseshoe-mounted telescope was lying on its side at near zero degrees altitude. The secondary assembly, mounted on a gimbal, had been rotated out of the optical path and two Tyvek-clad, hard-hat-wearing technicians were working on an instrument in the secondary cage. As a result, the telescope couldn't be slewed for us, but later on the dome was rotated. Unlike the 1.5-meter, the catwalk is attached to the dome, and so we rotated around the telescope with the dome appearing motionless.



The 4-meter telescope positioned for DECam maintenance

We were granted the apparently rare privilege of walking around on the telescope floor to inspect the instrument. The Victor Blanco telescope is a Ritchey-Chrétien with the mirror operating at f/2.87 at prime focus. The Dark Energy Camera (DECam, pronounced "dee-cam") works at this position. This $30 million instrument is a 520-megapixel wide-field imager (2.2 degrees field, 0.263 arc-seconds per pixel) that is carrying out the Dark Energy Survey, an international collaboration of some 400 astronomers and physicists from 25 institutions that will map hundreds of millions of galaxies, detect supernovae, and find patterns of cosmic structure, all in an attempt to elucidate the nature of dark energy. The DECam took 3 years to build. It was constructed at Fermilab and tested on a simulator that mimicked the secondary cage of the Blanco telescope. Of its 5 optical lenses, one is the largest corrector in use anywhere in astronomy today, almost 1 meter in diameter, weighing 330 pounds. Its filters are 24" in diameter. It is cooled and evacuated so that the CCDs are kept at 173° K (minus 100° C) at a pressure of 10^{-6} torr.





DES sensor array (DES)

The camera's spectral range is 300 to 1100 nm. We were told that it was so sensitive it could register

100,000 galaxies in a 17 second exposure (the typical exposure will be 90 seconds). The entire image can be read out in less than 30 seconds. The images are processed by supercomputers at Fermilab; thousands of terabytes of data are crunched to generate interpretable information. The project also picks up "transients," objects that change position from one image to another, so in addition to finding galaxies and supernovas DECam is finding new Kuiper Belt objects. It discovered 2014 UZ_{224}, a 23.2-magnitude dwarf planet now 90 AU from the sun. 2014 UZ_{224} is the second most distant solar system object, after Eris. The quality of DECam's 74 hypersensitive detectors (67 science detectors and 7 for guiding) can be seen in the image of NGC 1365, a barred spiral galaxy in Fornax.

NGC 1365 by DECam & 4-meter telescope (DES)

Modern research cameras and spectroscopes are complex devices. Their designs are always breaking new ground, so their performance characteristics have to be exhaustively studied to be able to apply accurate corrections to the data, eliminating any artifacts or imperfections. This is an incredibly intricate endeavor. The camera is not just taking pictures and making spectra: it's establishing the exact position, brightness and velocity of very faint objects. I recently saw a paper that analyzed DECam's operational performance. Although the fine details were far beyond my understanding, the 45-page article gave a sense of the meticulousness required to measure how the camera actually performs. The astrometric solution for the camera was found to be accurate to less than 6 milliarcseconds, about 0.02 pixels! (G.M. Bernstein and 55 other authors, Astrometric calibration and performance of the Dark Energy Camera, arXiv 3/5/17, https://arxiv.org/pdf/1703.01679.pdf).

The Victor Blanco telescope was upgraded in 2011 to prepare for the DECam, with new control and tracking systems, computers, ventilation and cooling. DECam saw first light on September 12, 2012. The Dark Energy Survey is planned to scan 5000 square degrees of the southern sky over 525 nights until 2018. The camera can be used for other observations when the DES team is not using the telescope.

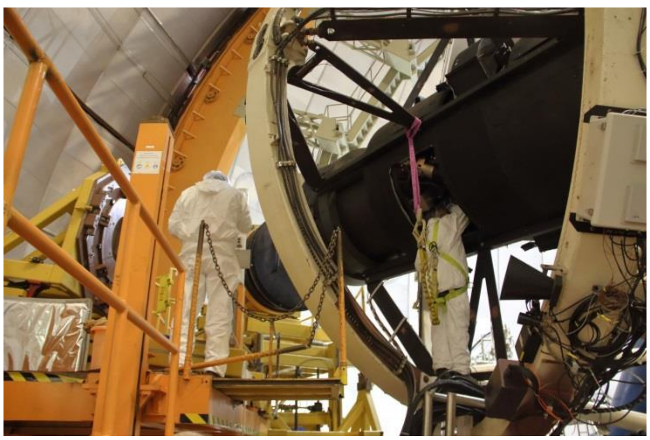
On the left is the old control panel for the 4-meter telescope, no longer used for regular telescope operations. The steel post erected to carry equipment on an upper level would have made it awkward to use anyway. The silver unit in the center is the cooling system for the DECam.

The telescope also operates in Cassegrain configuration at f/8. Two secondaries that gave longer focal lengths at f/14.5 and f/30 have been retired. Two instruments operate at the f/8 focus: the CTIO Ohio State Multi-Object Spectrograph (COSMOS), an imager and near-infrared spectrograph, and the Astronomy Research using the Cornell Infra Red Imaging Spectrograph (ARCoIRIS). It's one of 4 of these devices currently in use (the others are on the 3.5 meter telescope at Apache Point in New Mexico, the 5-meter Hale at Palomar in California and the 10-meter Keck II in Hawaii). Infrared observations can be made when the moon is near or full, so no clear nights are wasted. The targets are individual stars, looking for exoplanets. As long as the sky is clear or even relatively so, scheduled observing programs are carried out with one of the detectors. As conditions change, the operators can redirect the scope to different targets and even change instruments to optimize the value of the night.

The 4-meter telescope has had a remarkable impact on astronomy over its lifetime. It's made many observations of Supernova 1987a. Both Saul Perlmutter's Supernova Cosmology Project team and Brian Schmidt and Adam Reiss' High-Z Supernova Search team used the Blanco 4 meter telescope and prime focus imagers between 1994 and 1998 for some of their most critical observations, leading to the announcement of the accelerated expansion of the universe and the 2011 Nobel Prize. And now DECam may help solve the dark energy conundrum.

The primary cage, horseshoe mount and polar bearing.

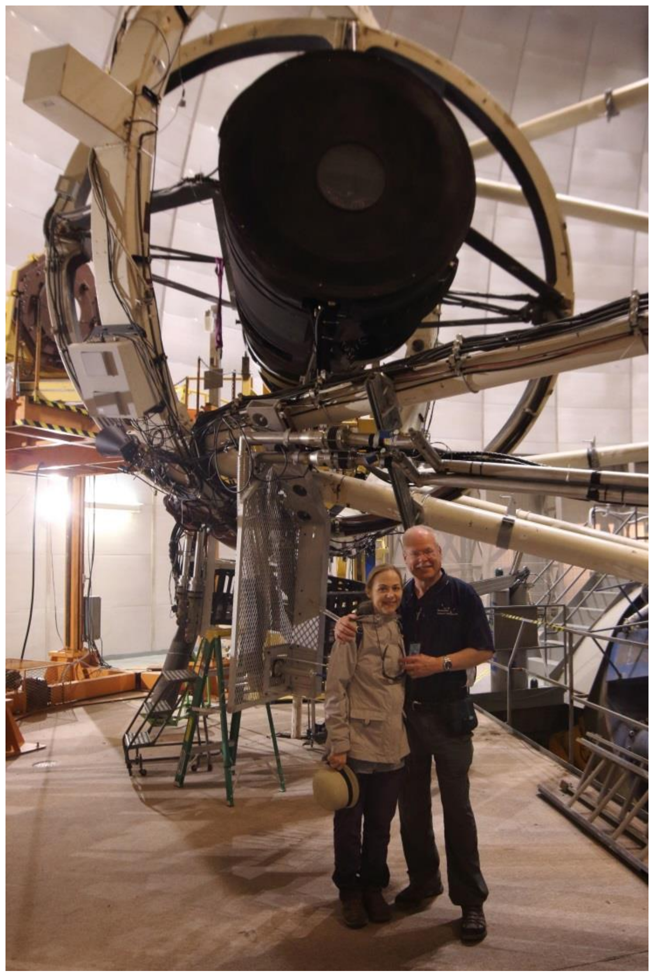
Construction of the telescope, and indeed all the large instruments in Chile, must be earthquake-proof. Early on, California standards for large-scale construction were adopted. The telescope sits on a reinforced concrete column that extends 25 meters into the mountain. The moving mass is 370 tons and the dome and support structures add another 300 tons. The secondary support weighs 8 tons. It has already survived 3 major earthquakes with little disruption.



Two workmen cleaning and maintaining the DECam

After one more opportunity to walk around the mountaintop among the telescope domes, we drove to a spot a little ways down the hill from the observatory and ate our box lunches in the luxurious sunshine and perfect temperature. We had a nice view of the dome of the Victor Blanco telescope on Cerro Tololo up the hill in front of us and in the distance to our right we could see the silver dome of the Gemini South telescope on Cerro Pachón that we would visit next. Gemini South looks like it's "right over there," just 6½ miles away, but it took at least 45 minutes to get there over a twisty, unpaved but well-maintained road. The story of the amazing 8.1-meter Gemini South will be related in next month's Sky*WAA*tch newsletter. ■

Aerial view of Cerro Tololo (CTIO)



Elyse and me under the secondary that houses the DECam
(Photo by Kelly Beatty)

The Shape of the Solar System

Marcus Woo

When Stamatios (Tom) Krimigis was selected for the Voyager mission in 1971, he became the team's youngest principal investigator of an instrument, responsible for the Low Energy Charged Particles (LECP) instrument. It would measure the ions coursing around and between the planets, as well as those beyond. Little did he know, though, that more than 40 years later, both Voyager 1 and 2 still would be speeding through space, continuing to literally reshape our view of the solar system.

The solar system is enclosed in a vast bubble, carved out by the solar wind blowing against the gas of the interstellar medium. For more than half a century, scientists thought that as the sun moved through the galaxy, the interstellar medium would push back on the heliosphere, elongating the bubble and giving it a pointy, comet-like tail similar to the magnetospheres—bubbles formed by magnetic fields—surrounding Earth and most of the other planets

"We in the heliophysics community have lived with this picture for 55 years," said Krimigis, of The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. "And we did that because we didn't have any data. It was all theory." But now, he and his colleagues have the data. New measurements from Voyager and the Cassini spacecraft suggest that the bubble isn't pointy after all. It's spherical.

Their analysis relies on measuring high-speed particles from the heliosphere boundary. There, the heated ions from the solar wind can strike neutral atoms coming from the interstellar medium and snatch away an electron. Those ions become neutral atoms, and ricochet back toward the sun and the planets, uninhibited by the interplanetary magnetic field.

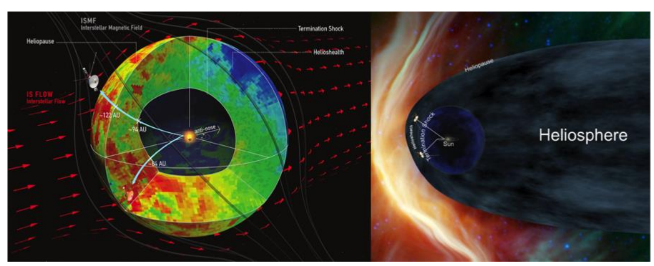
Voyager is now at the edge of the heliosphere, where its LECP instrument can detect those solar-wind ions. The researchers found that the number of measured ions rise and fall with increased and decreased solar activity, matching the 11-year solar cycle, showing that the particles are indeed originating from the sun.

Meanwhile, Cassini, which launched 20 years after Voyager in 1997, has been measuring those neutral atoms bouncing back, using another instrument led by Krimigis, the Magnetosphere Imaging Instrument (MIMI). Between 2003 and 2014, the number of measured atoms soared and dropped in the same way as the ions, revealing that the latter begat the former. The neutral atoms must therefore come from the edge of the heliosphere.

If the heliosphere were comet-shaped, atoms from the tail would take longer to arrive at MIMI than those from the head. But the measurements from MIMI, which can detect incoming atoms from all directions, were the same everywhere. This suggests the distance to the heliosphere is the same every which way. The heliosphere, then, must be round, upending most scientists' prior assumptions.

It's a discovery more than four decades in the making. As Cassini ends its mission this year, the Voyager spacecraft will continue blazing through interstellar space, their remarkable longevity having been essential for revealing the heliosphere's shape."Without them," Krimigis says, "we wouldn't be able to do any of this."

To teach kids about the Voyager mission, visit the NASA Space Place. This article is provided by NASA Space Place. With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology. Visit **spaceplace.nasa.gov** to explore space and Earth science!



New data from NASA's Cassini and Voyager show that the heliosphere — the bubble of the sun's magnetic influence that surrounds the solar system — may be much more compact and rounded than previously thought. The image on the left shows a compact model of the heliosphere, supported by this latest data, while the image on the right shows an alternate model with an extended tail. The main difference is the new model's lack of a trailing, comet-like tail on one side of the heliosphere. This tail is shown in the old model in light blue.

Image credits: Dialynas, et al. (left); NASA (right)

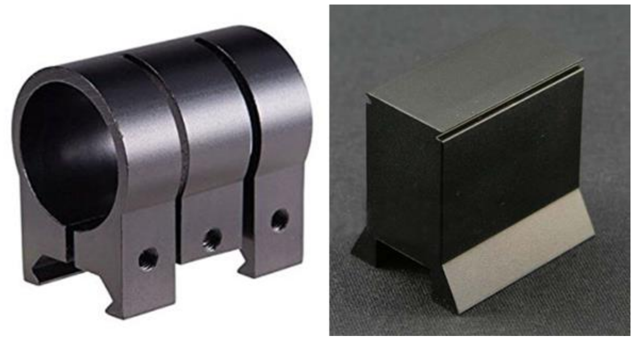
Swords into Plowshares: Laser Finder Made from a Weapon Accessory

If you like to use a laser as a finder scope (it's a very good way to point your scope at bright stars during your initial alignment routine), your primary option was a pencil-type laser mounted in a 6-screw finder bracket like those made by Lumicon or Orion.

Pencil-type laser on a Lumicon bracket

The main problem with this system is that it's clumsy to activate the laser. Most pencil-type lasers have a button on the shaft that's in an inconvenient position when the laser is on one of these brackets. I had an old pencil-type laser that I got from Howie Glatter. He made a replacement end cap with a foot of 2-conductor wire and a momentary contact switch (the button on the shaft is held down with an O-ring), but this tweak is no longer available. I wanted another laser for my CPC800, and in searching on line I came upon a 5 mw green laser that's intended for mounting on a firearm in order to make it easier for you kill Bambi's mom. The "Pinty Hunting Rifle Green Laser Sight Dot Scope Adjustable with Mounts" was quite reasonably priced at less than $22 on Amazon.

Included are two mounting devices. One, a figure-8 contraption designed to fit on the barrel of a rifle, was of no value to our project, but the other was perfect. It was intended to clamp the laser to a mounting dovetail on a weapon, but it also fits a mounting post made for certain finder scopes. I used the "Agena Type B1 Mounting Bracket for Agena Multi Reticle Reflex Finder" from Agena Astro (www.agenaastro.com), a $12.95 item. This has an undercut just below the top for clamping the finder. Its base fits the standard Orion/Synta dovetail finder shoe present on many telescopes, (and if yours doesn't, the scope or focuser may already have tapped holes for a dovetail shoe). The laser bracket was a tiny fraction too narrow to slide onto the finder mounting bracket, but all I had to do was spread the front and rear rings a fraction of a millimeter with a flat-head screwdriver and then slide it onto the mounting bracket. Supplied metric screws lock the parts together, and the middle the ring solidly holds the laser in place. The correct metric hex wrench is also included. It's a very rigid mounting.



(L) Laser bracket; (R) Finder mounting bracket

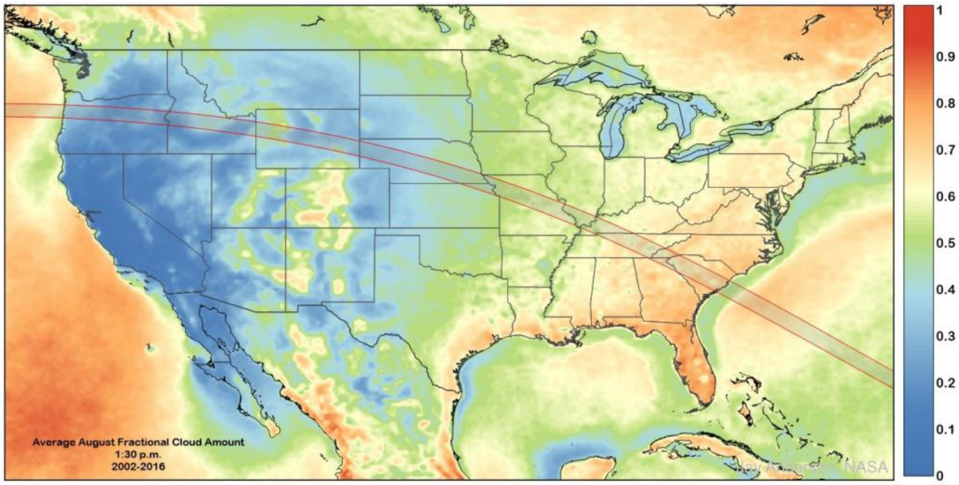
For alignment of the beam with the scope's optical axis there are two knobs on the housing positioned 90 degrees apart. One moves the beam up and down and the other left to right. It's much easier and more intuitive to exactly place the beam than fiddling with the thumbscrews on a traditional finder bracket and trying to guess which direction the beam will move.

The housing has a rear power button, which makes it simple to turn the laser on from the eyepiece position at the scope. Even better, the button can be replaced with an included rubber-encased momentary contact switch on a flexible coiled wire.

The laser uses a Cr123A lithium battery, the type that powered our old 35 mm film cameras. They are long-lasting and inexpensive. The total weight of laser, bracket, battery and contact switch is 9½ ounces.

Larry Faltz

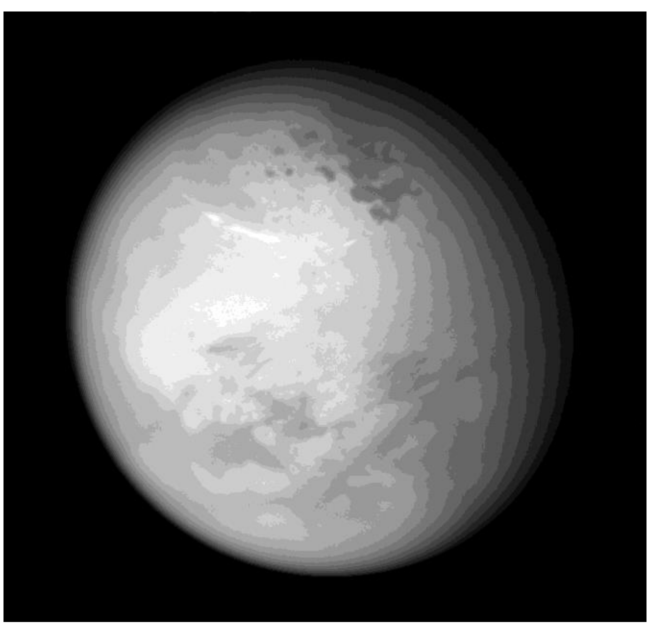
Astrophotos



Where to See the American Eclipse

Are you planning to see the American Eclipse on August 21? A few hours after sunrise, a rare total eclipse of the Sun will be visible along a narrow path across the USA. Those only near the path will see a partial eclipse. Although some Americans live right in path of totality, surely many more will be able to get there after a well-planned drive. One problem with eclipses, though, is that clouds sometimes get in the way. To increase your clear-viewing odds, you might consult the above map and find a convenient destination with a historically low chance (more blue) of thick clouds overhead during totality.

Image Credit: Jay Anderson; Data: MODIS Satellite, NASA's GSFC
Credit: APOD



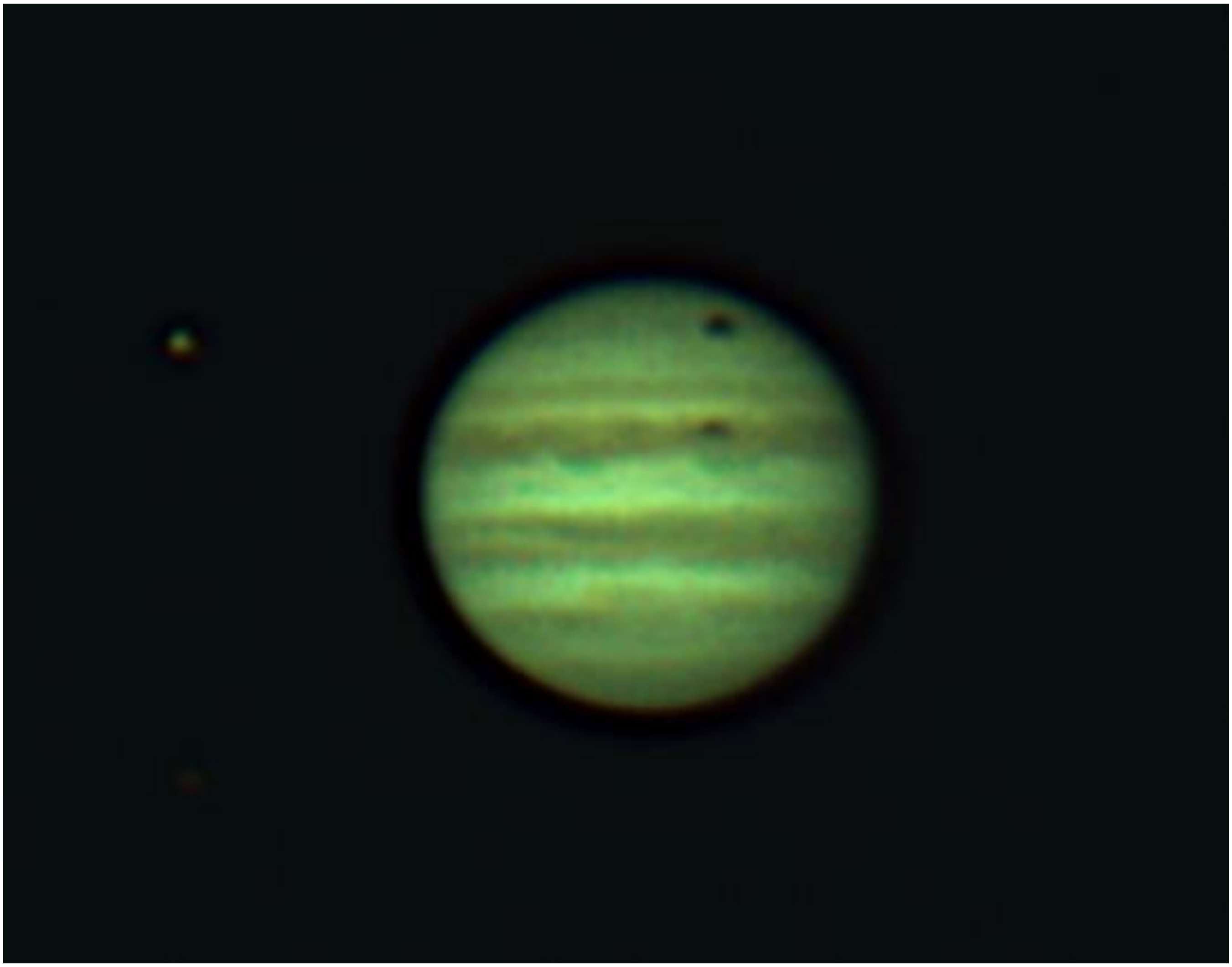
Northern Summer on Titan

While the recent solstice brought summer to planet Earth's northern hemisphere, a northern summer solstice arrived for ringed planet Saturn nearly a month ago on May 24. Following the Saturnian seasons, its large moon Titan was captured in this Cassini spacecraft image from June 9. The near-infrared view finds bright methane clouds drifting through Titan's northern summer skies as seen from a distance of about 507,000 kilometers. Below Titan's clouds, dark hydrocarbon lakes sprawl near the large moon's now illuminated north pole.

Image Credit:
Cassini Imaging Team, SSI, JPL, ESA, NASA

Credit: APOD

Double Shadow Transit of Jupiter



Double shadow transit of Jupiter on 6/3/17 at about 10:40 pm. Celestron CPC800 prime focus (f/10). Celestron NexImage 5. Transparency 8/10, seeing 4/10. I was only able to capture about 450 frames because of memory limitations on the small Winbook tablet I was had with me, and as a result the image is much noisier and less detailed than it could have been. Best 25%, stacked with Autostakkert!2, Wavelets in Registax 6.1, final color adjustment in Photoshop Elements.

The shadows are of Ganymede (top) and Io. Ganymede is the bright moon at 10 o'clock. Io is in front of the planet, overlying the North Equatorial Band (upper thick band) just to the left of a slight blue feature but not really visible at this resolution or imager sensitivity. Callisto can barely be made out about the same distance as Ganymede but at 7:30 o'clock. Europa is just off the edge at 4 o'clock but is too faint to be seen on the image.

--Larry Faltz.