SkyWAAtch

Starway to Heaven

Larry Faltz provided this pretty photo of a sunset and waxing crescent Moon. Notes Larry: A layer of ground fog begins to creep across the lawn west of the Meadow Parking Lot at Ward Pound Ridge Reservation at 8:30 pm at the beginning of WAA's August 6th star party. In spite of a lot of humidity and some intermittent fog, the sky was often excellent. The sky quality meter reading was 20.30 during the darkest parts of the evening with the Milky Way visible overhead. A total of 8 telescopes ranging from 3" to 16" were on the observing field. iPhone 6 photo.

In This Issue . . .

Events for September

WAA September Lecture

"Member Presentations Night"
Friday September 16th, 7:30pm
Leinhard Lecture Hall,
Pace University, Pleasantville, NY

WAA members will showcase their photos, equipment and astronomy insights. So if you've done something interesting astronomically this summer, gotten a new piece of equipment, or made some images and would like to talk to fellow club members about it, contact Pat Mahon, WAA Vice President for Programs, Directions and Map

Upcoming Lectures

Pace University, Pleasantville, NY

Our October meeting will be October 7th (speaker to be determined). On November 4th, Dr. Kenneth Kremmer will speak on rocket technology.

Starway to Heaven

Saturday September 24th, Dusk.
Ward Pound Ridge Reservation,
Cross River, NY

This is our scheduled Starway to Heaven observing date for September, weather permitting. Free and open to the public. The rain/cloud date is October 1st. **Important Note**: By attending our star parties you are subject to our rules and expectations as described here. Directions and Map.

New Members. . .

Jak Cukaj - Katonah
Jason Gleis - New Rochelle
Diane Castro - Mount Kisco

Renewing Members. . .

Joe Geller - Hartsdale
Robert Danehy - White Plains
Anthony Monaco - Bronx
Andrea Anthony - Yorktown Heights
Scott Nammacher - White Plains
Jose E. Castillo - Pelham Manor
Doug Baum - Pound Ridge
Harry Vanderslice - Mamaroneck
Steve Petersen - Briarcliff Manor
Linda Boland - Hyde Park
Eileen Fanfarillo - Irvington

Above is an image of Pluto that Larry Faltz captured the day after the August 27th WAA Starway to Heaven (processed and annotated image in black and white). He had shown Pluto at the star party on a video screen. Not much more than a pixel; so you should zoom-in with your pdf-reader. It's not going to win any prizes, observes Larry, but it shows Pluto. I need to find the best half dozen of the ones I have and stack them with Deep Sky Stacker and see if that helps. I made a dark frame to eliminate about 4 hot pixels that DSS can use. Pluto is mag 14.2. The star to its left is UCAC4-344-176359, mag 13.07.

WAA Apparel

Charlie Gibson will be bringing WAA apparel for sale to WAA meetings. Items include:

- Hat ($15)
- Polos ($15)
- Tee shirts ($12)

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

Westchester Amateur Astronomers

ALMANAC

For September 2016 by Bob Kelly

Sep 1 Sep 9 Sep16 Sep 23

Mars continues to flee from Scorpius into Sagittarius, tripping over Ophiuchus, the serpent bearer, on the way. Perhaps it sees Saturn and Scorpius falling low in the southwest toward the Fall Sun. Antares must wonder what happened to the party they were having in August.

Mars is nearby Earth, compared to the outer planets, and bright at magnitude minus 0.2. But it's so small at 9.5 arc seconds a good telescope might only hint at shades of gray or a spot of white in the ocher hue of the warrior planet. Mars is noticeably out of round; 85 percent sunlit in a telescope. Mars' nearness, combined with Earth's speed on the inside track, gives Mars its apparent motion smartly to the left (east) and shrinking size as Earth beats a speedy retreat behind the Sun, from Mars' point of view.

Venus' slow climb into our Northern Hemisphere skies presages a long, lingering stay in the evening sky. Venus is 90 percent sunlit, waxing, frustratingly low and small at 11 arc seconds wide, but increasing out to 30 degrees from the Sun. Once you sight the brightest planet, it'll be yours for the rest of the fall into spring 2017.

Attention, Science Teachers! The Abrams Planetary Sky Calendar recommends the daytime moon high in the daytime sky from the 7th to the 10th and the 21st through the 25th as a great introduction to astronomy for school classes during school hours. Check the Sky Calendar for details.

Mercury keeps its title as the closest planet to Earth in September, but Jupiter and Saturn still are the largest planets as seen from Earth, at 30.6 and 16.4 arc seconds, respectively, despite their great distances. Catch Saturn and its rings early in the evening.

Jupiter flirts with Venus and the Moon very low in the west on the 2nd and 3rd before decamping into the solar glare. Mercury peeks out from behind the Sun in late September, low in the eastern morning sky, hopping straight up from the Sun just before sunrise for the final decade of days in the month. Mercury waxes past 50 percent full by the 28th. Regulus is the slightly dimmer star more than a fist-width higher. It may be more obvious than Mercury.

Use SOHO's C3 camera to keep tabs on Jupiter and Mercury as they hide in the solar glare from Sept. 15th through Oct. 6th, and Sept. 9th to 17th, respectively.

Catch the 8th planet, Neptune, as we reach opposition on the 2nd. At magnitude +7.8 and 2.3 arc seconds wide, Neptune looks non-star-like in telescopes. Uranus rings in at magnitude +5.7 and 3.7 arc seconds wide. This is as big and bright as they get, so the next few months are the time to seek them out. Note that Uranus and Neptune are moving northward each year, so they are getting higher in the sky when they transit our southern sky. This keeps up for the next several decades.

Pluto's still in the teaspoon of Sagittarius, but over the years will get fainter than its present magnitude +14, staying low in the southern sky.

Get to dark skies and wait as your eyes get used to the dark to catch the irregularities of the Milky Way arcing high over us this month.

The ISS blazes through the morning sky for most of September. Evening appearances are scheduled for the last few days of the month, into much of October.

The September Equinox happens at 5:57am on the 22nd, as the Sun appears to cross the celestial equator and heads south for the winter.

A not-quite total eclipse of the Sun leaves a ring of blinding sunlight around the Moon, crossing Africa on the 1st. A faint, penumbral eclipse of the moon happens on the other side of the world from us on the 16th.

Westchester Amateur Astronomers

We Visit the 200-inch Hale Telescope at Mount Palomar

Larry Faltz (photos by the author, except as noted)

After our remarkable tour of the Jet Propulsion Laboratory in Pasadena (see the July 2016 SkyWAAtch), Elyse and I met up with Dr. Charles Lawrence, JPL's Chief Scientist for Astronomy and Physics, who had suggested in our pre-trip email exchanges that he wanted to take us to the famous 200-inch Hale telescope at Mount Palomar. That was an offer impossible to turn down, and so about 11:30 am the three of us set out on the 120-mile, 2½-hour drive in our comfortable rented VW Passat.

It's freeway driving a good bit of the way. First about 45 minutes through the flat, boring Los Angeles basin, heading towards Riverside, then south to the city of Corona onto I-15. Here the freeway runs in a pleasant valley with low hills on either side. We stopped for lunch at Charles's usual spot, the In-and-Out Burger in Lake Elsinore, and then headed south another 20 miles to Temecula. We drove through the town of Pechanga, which seems to have been purpose-built to house a garish Native American casino and resort. Thankfully the road soon plunged into the countryside of northeastern San Diego County, twisting its way through scenic hills dotted with large sandstone boulders, until it reached the tiny town of Pala. We proceed east on Route 76 through the orange groves of Pauma Valley until we came to South Grade Road. Five miles of twisty, ever-rising driving through pine forests took us to the top of Palomar Mountain, some 5,616 feet above sea level.

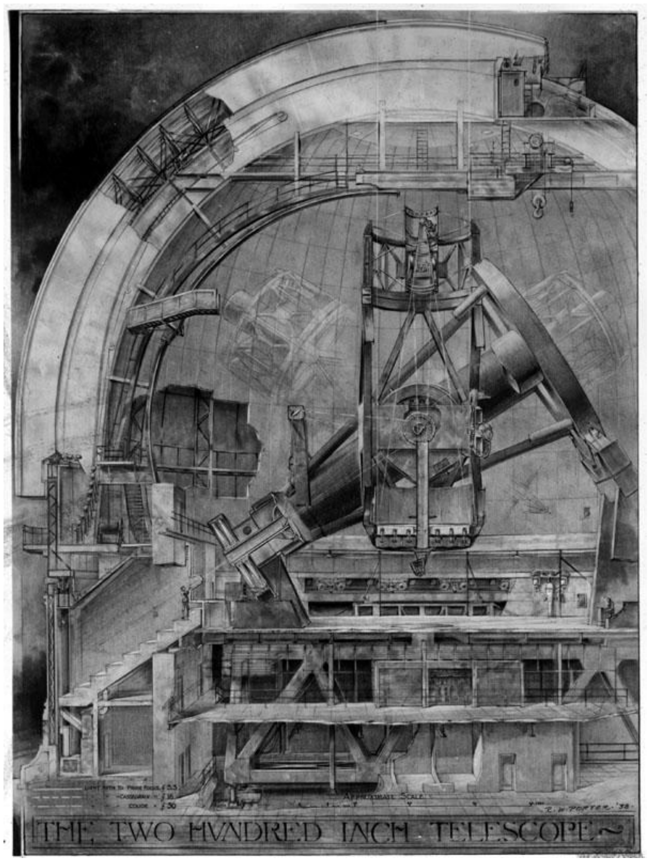
The observatory is situated on a broader and more open summit than the apex of Mt. Wilson (see the August 2016 SkyWAAtch), with telescope domes and support buildings scattered among areas of forest and meadow. The instruments are not close to each other, providing a sense of isolation and serenity. There weren't any people about, although in the dome we ran into several astronomers and scope operators working on a new adaptive optics system for the 200-inch.

The Monastery

We stopped at the building that houses living quarters for visiting astronomers to get the key to the 200-inch. There was a sign in front of it, "Monastery", and thus the nickname given to the living quarters on Mt. Wilson has become the formal name of its Palomar counterpart. Then we drove back and around to the small parking lot in front of the beautiful dome of the Hale.

Dome of the Hale Telescope

The dome is very stately, simple and can even be said to be "elegant." The chief architect of the observatory, responsible for the dome, grounds and overall design of the Hale itself, was Russell Porter, famous to amateur astronomers as the founder of Springfield Telescope Makers and Stellafane. Porter was a superb architect, surveyor, artist and painter with remarkable drafting skills and a perceptive eye. He was a pioneer in the craft of "cutaway" drawings. His pen-and-ink illustrations of the telescope remain famous to this day. Porter's design reflects the dominant art-deco style prevalent in southern California in the 1920's and 30's, with simple moldings harmonizing the dome's cylindrical and spherical elements.



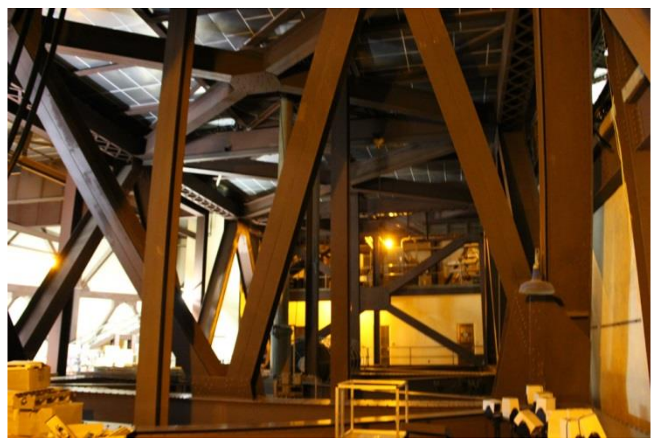
Porter's cutaway drawing of the Hale, one many drawings he executed for the design (Palomar)

The dome mirrors the size and proportions of the Pantheon in Rome. It can contain a 12-story building, but because its proportions are so balanced and also because of the subtle influence of Porter's trim, from the outside it doesn't seem overly massive.

Although there is a public entrance to a visitor's gallery up a flight of stairs, we entered the dome at ground level after having inspected the massive 200-inch diameter concrete disc that was used to balance the telescope before the mirror was installed. The disc sits on the side of the parking lot, not having been moved since it was deposited there in 1947.

Concrete balance weight

The ground level of the telescope houses a mass of girders that supports the telescope and the floor of the dome. The telescope's support members are isolated from the dome foundation, so there are no vibrations caused by movement of the dome or footsteps of the staff. Additional earthquake-resistant supports have been added over the years. There were various items being stored in the cavernous chamber: crates, dewars for liquid nitrogen, cables, ladders. It was, in other words, the basement.



Supports under the telescope

Walking up a flight of stairs, we entered a hallway that looked a little like the corridor of my old grammar school. Many of Porter's drawings were mounted on the walls. Solid walnut doors opened to a series of what appeared to be workrooms. Some of the rooms clearly were being used for storage or mechanical workshops and some housed utilities. It looked to me that no one in astronomy ever throws anything out. A room labeled "Darkroom" was completely filled with junk: old enlarger heads, antiquated small TV monitors, a myriad of once-useful equipment that was made obsolete by the march of technology and the transformation of astronomical imaging to a digital craft. Another room had a lovely old pool table, purchased reluctantly, so the story goes, by Palomar's first director, Ira Bowen, so that staff would have something to entertain themselves with when the sky became unacceptable for viewing.

Office and Workshop corridor

Through a door we passed into the formal entrance to the telescope, with stairs heading up to the public viewing gallery and a bust of Hale with dedicatory plaques. Sadly, Hale did not live to see the instrument fully constructed or operational.

Bronze bust of Hale and dedicatory plaque

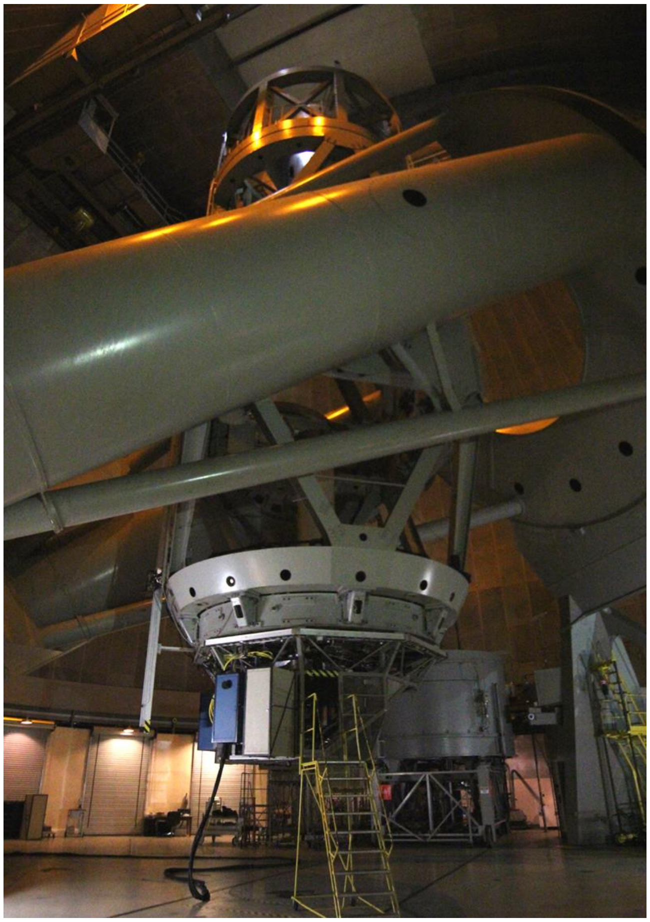
Rather than going to the visitor's gallery, we went through another door to enter the upper level of the support cavern, and examined the pumps, pipes and gauges that fed the telescope's RA bearings, which ride on a very thin film of oil. The Hale was the first telescope to use this technique, stronger and more reliable than roller bearings or the mercury bearings used on the Hooker at Mt. Wilson. It's now standard on large instruments. Charles showed us one of the main electrical panels. Original 1940's relays and switches coexisted with modern devices, suggesting that upgrades of the telescope are often an "as-needed" process.

Charles Lawrence and Elyse at one of the electrical panels

Further on, we passed a room with many servers and computer equipment, evidence that the days of glass plates, darkrooms and astronomers spending the night freezing and immobile in the observing cage are over.

A wide-angle image courtesy of Palomar Observatory

Finally we emerged on the telescope floor and looked up at the gigantic and iconic instrument. I'm not a good enough writer to express our sense of awe or a good enough photographer to capture the scene properly, especially since the inside of the dome was not brightly lit and I didn't have a tilt-and-shift lens or even a tripod. The inside space seemed enormous, much bigger than one would have thought recalling the view of the dome from outside. The telescope was pointed straight up, its usual parked position, so that the staff could work on equipment under the primary.

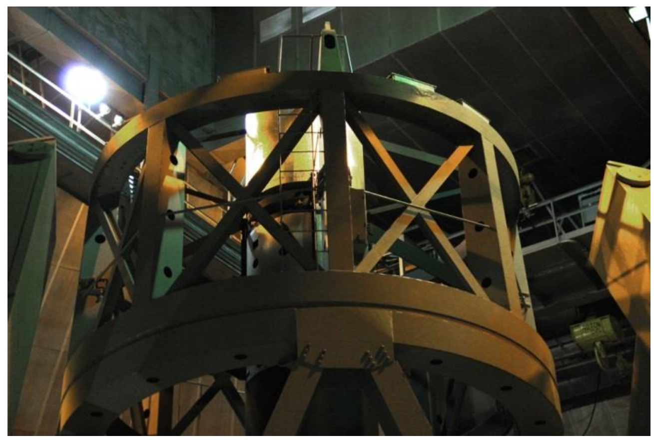


View from the telescope floor. The stepladder leads to the cage under the primary.

We spent a good deal of time walking around the floor and gazing up at the instrument while Charles described the remarkable experiences he's had during over 100 nights of observing for his various research projects.

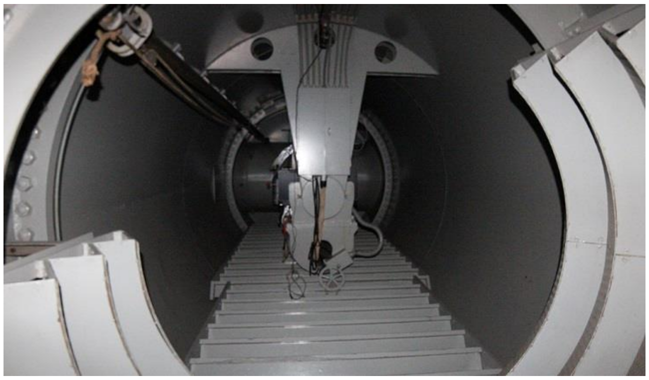
The telescope mirror is figured to f/3.3, much faster than either major telescope at Mt. Wilson, giving it a focal length of 16,764 mm. If I was allowed to use the telescope visually from prime focus (which of course I was not), I'd want the exit pupil to be less than 5.5 mm because my 68-year old eyes can't dilate like they used to. (Remember the formula: exit pupil = aperture divided by magnification.) A reasonable eyepiece to use would be a 17-mm 82° Televue Nagler Type 6, giving 986x magnification with an exit pupil of 5.15 mm. The true field would be just 5 arc-minutes. The actual imaging field at prime focus is wider.

In the old days, astronomers sitting in the cramped observing cage would guide the instrument manually, alone in the cold, unable to relieve themselves should their bladders fill, until the photographic plate was fully exposed. Then they'd rush down to the darkroom, develop and examine the plate, and climb up again to make another. Astronomers reach the prime focus cage by a small open lift on a track that ascends on the inside of the dome. Charles described the disorienting sensation he once had riding the track while the operators rotated the dome and slewed the telescope at the same time. Anyone using that conveyance now needs a fully-rigged safety harness and needless to say we neither expected nor were offered the experience.



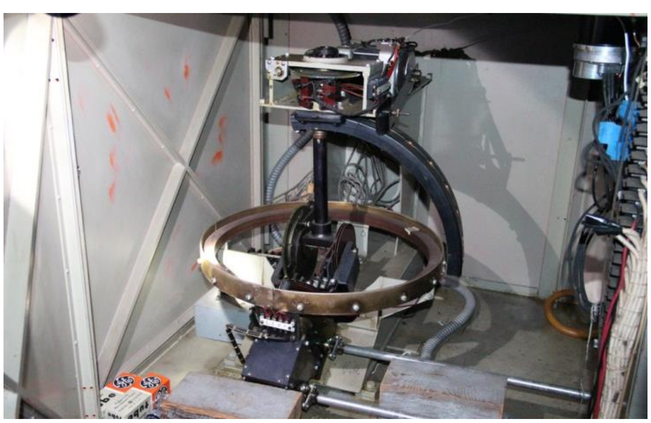
The prime focus cage at the top of the telescope

In Cassegrain configuration, the secondary reflects the light through the hole at the center of the mirror. The focal plane is at f/16, giving a focal length of 81,280 mm. Now, any amateur telescope eyepiece would provide a small enough exit pupil, so let's use a 31mm 82° Nagler Type 5. This gives 2,622x with an exit pupil of 1.94 mm and a field of view of just 1.9 arc-minutes. We might do better with the simpler 50mm Televue Plossl, (1,478x, 3.44 mm exit pupil, 2.0 arc-minute field of view). This focus is also used for imaging and spectroscopy and is the site of a new high-technology adaptive optics system, to be described later. There is also a Coudé focus, with a focal length of f/30 (152,000 mm focal length) that was designed for spectroscopy, the light beam directed out the side of the telescope to a room under the dome containing large, adjustable gratings, lenses and imaging equipment. That room seemed little used of late. Additionally, the designers also installed a Nasmyth focus, which projects the beam out the side of the East altitude bearing. The instruments at this focus are actually housed in the hollow fork arm, and are reached by clever rotating stairs from the south end of the fork that allow the astronomers to climb up the fork arm regardless of the orientation of the telescope as it rotates on its polar axis.



Inside the east fork arm

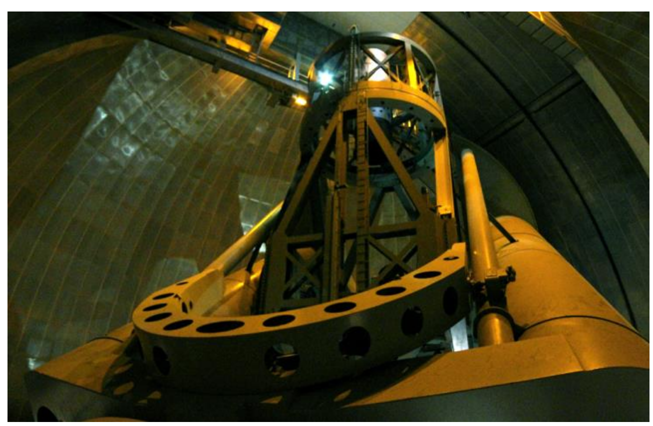
On the way to the Coudé focus room, Charles showed us the “phantom telescope” that tracked and recorded all of the movements of the instrument to ensure that the dome and the telescope remained in sync. This miniature abstract model of the Hale was designed by Sinclair Smith, who was responsible for the complex control mechanisms of the Hale but died prematurely of cancer at the age of 39 before all of the unique systems were in place, leaving it to Edward Poitras to finish the work. The design parameters called for the periodic error of the 530-ton instrument to be less than 0.1 arc-second, with the system designed to compensate for flexure of the tube and mount and even for atmospheric refraction. The Hale was constructed in the pre-digital age. Control systems were made from relays, mechanical sensors and vacuum tubes. Most, if not all, have been replaced by digital optical encoders and computerized controllers, as one would expect.



The “phantom”, just 2 feet high

The original telescope control panel, now obviously out of service, sits on the main floor. It has analog sidereal and local time clocks, digital panel meters and rotating measuring wheels to display telescope and dome position. The telescope control center is now situated in a cozy suite of rooms for the technicians on the side of the main floor. Some of the controls are still analog, but of a more recent vintage, with the most important functions completely digitized.

Old control panel (top), modern control room (bottom)



View from near the lower polar bearing

We went up a flight of stairs to the mezzanine level to get another angle on the instrument and to examine the dome, the mount and the massive polar bearings. The equatorial horseshoe design, basically a version of an English yoke, allows full-sky coverage unlike the pure English yoke of the 100-inch Hooker telescope at Mt. Wilson.

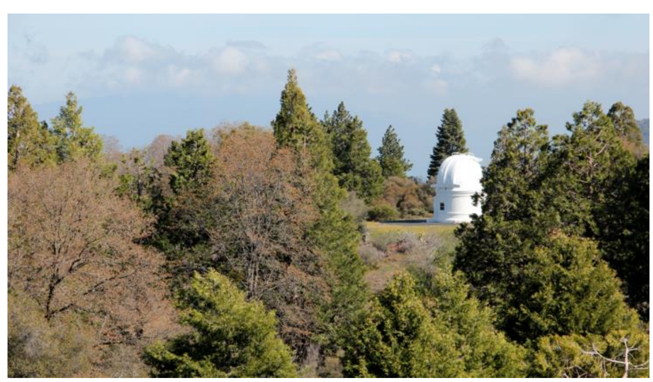
Three views of the upper horseshoe bearing

The lower bearing contains the motor that drives the telescope in right ascension. The polar axis motor is only 3 horsepower. The massive upper polar "horseshoe" bearing is one of the telescope's most recognizable and unique features. Constructed of huge plates of welded (rather than riveted) steel, the sections had to be transported up the mountain and welded in place to exacting tolerances. Along the lower edge are gauges and tubing for the oil, which forms a lubricating surface just a few thousandths of an inch thick and allows the 3-horsepower polar motor to do its work. The telescope is so finely balanced that when the mount was first installed, the weight of a milk bottle would move it.

The dome has an external sheath of steel and an internal lining of aluminum with a 4-foot air space in between for insulation. It weighs 1,000 tons. The shutters weigh 125 tons each. The dome is driven by four 7.5 horsepower motors.

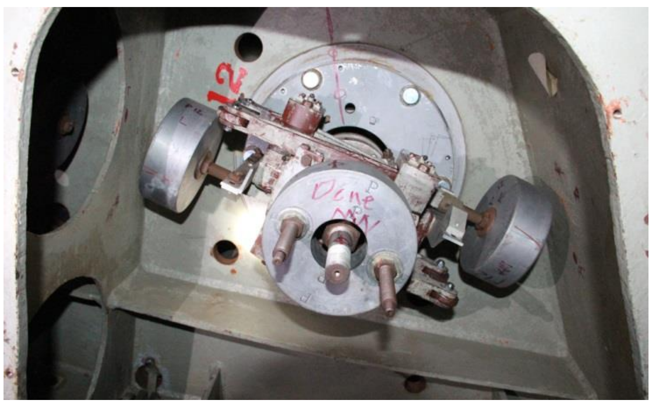
Charles and Elyse at one of the dome motor units

We took a lap around the parapet on the outside the dome. From there we could see the other telescopes on Mt. Palomar: the 48-inch Samuel Oschin telescope, a wide-field Schmidt survey instrument also designed by Russell Porter, and the 60-inch Ritchey-Chretien instrument, also a wide-field robotically controlled instrument. We also saw the dome of the now-decommissioned 18-inch Schmidt astrograph, the first telescope on the mountain (1936). It was primarily used by Fritz Zwicky to find supernovas and later by Eugene Shoemaker, David Levy and others to discover near-earth asteroids and comets.



The dome of the now-decommissioned 18-inch telescope

Once back inside from the rather cold and windy exterior, we went to the floor of the telescope and were invited to climb into the cage under the primary mirror. The famous 200-inch mirror weighs 14.5 tons and is almost 2 feet thick at its periphery. However, much of the thickness is taken up by the honeycombed backing, and so the solid surface is only about 4½ inches thick at its center. Although the mirror's figure is ground to within a millionth of an inch, under the influence of gravity the figure changes as the telescope's position changes. To maintain the curvature to the exacting standard required, a series of counterweighted compensators were installed. New research telescopes have mirror supports that operate by computer, but in the 1930's they were completely mechanical devices.



One of the compensators on the mirror support. No wires!

The cage is big enough for several people to occupy in spite of containing a good bit of optical, electrical and computer equipment and lots wires. The new Palm-3000 adaptive optics system at the Cassegrain focus consists of an enclosed optical train with a deformable mirror that uses 3,388 actuators to change its shape in response to atmospheric conditions.

The instrument cage under the primary mirror

Elyse standing in the cage under the primary mirror. Palm-3000, with its covering on, is to the right.

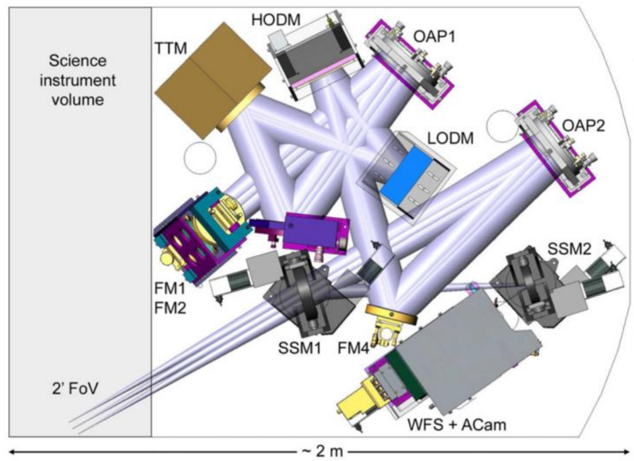
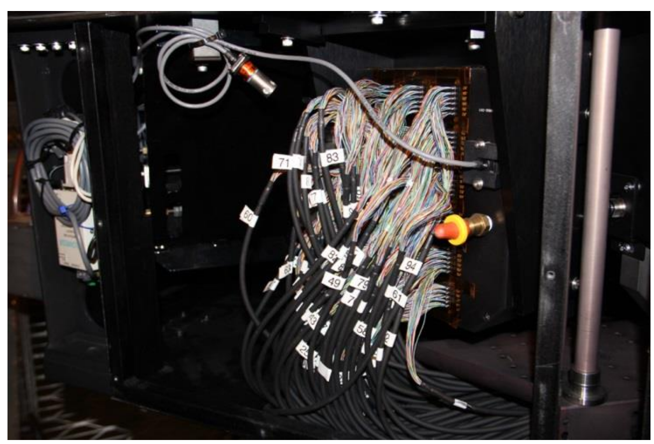


Diagram of the Palm-3000 adaptive optics system (Astrophysical Journal 2013; 776:130)



Inside Palm-3000: If you have 3,388 actuators, you probably need at least 3,388 wires

We had the opportunity to meet Chris Shelton and Rick Burriss, two of the JPL astronomers working with the Palm-3000, which had been scheduled for some engineering tests later in the evening. With this instrument, the Hale telescope will perform high-contrast imaging and emission spectroscopy of brown dwarfs and large planetary mass bodies (exoplanets) at near-infrared wavelengths. The adaptive optics system can use a guide star down to magnitude 17, and the system can improve seeing by a factor of 10-20 over the mirror's diffraction limit. There are a number of other instruments, including both narrow- and wide-field cameras and spectrographs, which keep the Hale productive as a general research telescope. It is particularly valuable in the near-infrared band.

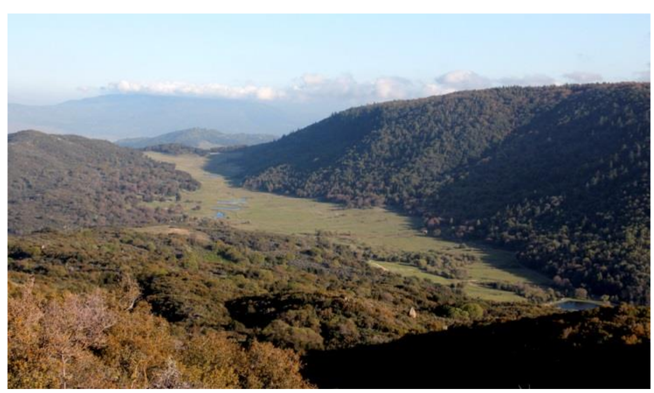
We finished our visit, which lasted almost 3 hours, in the control room and office area off the main floor, meeting several other astronomers and scope operators. Someone with a sense of humor had mounted one of the (optically dreadful) 50-mm Galileoscopes on the wall.

After our visit, we drove back down South Grade Road and through the countryside back to I-15, in conversation with Charles the entire way. We had dinner at a Mexican restaurant in the Old Town area of Temecula, and retraced our steps to the Pasadena area, where we arrived at about 10:30 pm.

This was a special day, and could not have occurred without the generosity, enthusiasm and patience of Charles Lawrence, who took a day out of his life to chaperone Elyse and me to one of the special places in the world of astronomy. Charles regaled us with more information than I could possibly relate, but the most interesting were about his experiences as a user of this remarkable, historic and beautiful instrument.

The Hale telescope took 20 years to build, a period that also saw the Depression and the Second World War. The design, materials, construction details, control systems, mounting, transportation logistics, human resources and financing were all unique, mostly untried and untested. No piece of glass that large had ever been poured, and it took several tries, first by General Electric with quartz and finally by Corning with Pyrex, to make an acceptable blank. The polishing took several years. No observatory had ever been sited so remote from its engineering or management base. The story of how the Hale was built is so remarkable that it deserves its own article in SkyWAAtch, and that's coming next month. ■

Another view, foreshortened by my wide-angle lens



Looking southeast from the observatory

Tom Boustead Celebrates 10 years as *SkyWAAtch* Editor

With this issue of Sky*WAA*tch, Tom Boustead celebrates a decade at the helm of the club's newsletter.

How did you get interested in astronomy?

I don't remember a specific event that got me interested. As a kid (12 or so) my twin brother and I had a 4" Criterion reflector that we used on the planets and bright Messier objects. I liked science fiction and was enthralled by the 1960's space program.

How did you become newsletter editor?

I took over the newsletter with the September 2006 issue. Dick Shaw had been doing it, but Bob Davidson actually handled the transition. Bob did about everything for the club back then and was looking for someone to take one of his hats.

What was your first telescope? What do you use now?

Besides the 4" reflector, my first wholly owned scope was a 10" dobsonian I constructed in the early 80's out of plywood, Sonotube and a Coulter mirror. It worked pretty well and I used it from a dark site at my father-in-law's place in the Catskills. Sadly, it was stolen from a shed up there after 3 years.

What are your favorite objects to observe?

I like clusters, open and globular, as well as planets. I use an 8" dob now and a 90mm refractor, which limits my options. I don't mind taking a peak through a large dobsonian at any deep sky object!

What astronomical events do you most enjoy?

I like the club's observing sessions at Ward Pound Ridge and especially the Rockland Astronomy Club's Summer Star Party in the Berkshires.

What do you do professionally?

I'm retired now. I was an economist at REFCO. Thereafter I worked for a time as bookseller at Borders.

Tell us about your family.

My wife is a college counselor at a high school. One son is working on his Master's degree in education and my other son works in finance. My daughter is a post-doc in public policy at the Kennedy School.

What other things interest you?

I'm an avid walker and a committed fan of the NY Mets and Villanova Wildcats basketball (my alma mater).

Each month without fail, Tom sends out requests for copy and images, composes the newsletter in Microsoft Word, makes a pdf file and sends it to our webmaster, Dave Parmet, for posting on the web site. Then we send an eblast to members announcing its availability. Sky*WAA*tch is now one of the premiere astronomy club newsletters in the country. We'd like to appoint an Assistant Editor. If you can help, please let us know. Your participation, either submitting articles or images, or assisting Tom in the editing and compositing tasks, will be much appreciated. Email Tom at waa-newsletter@westchestersastronomers.org.

Westchester Amateur Astronomers

Is there a super-Earth in the Solar System out beyond Neptune?

Ethan Siegel

When the advent of large telescopes brought us the discoveries of Uranus and then Neptune, they also brought the great hope of a Solar System even richer in terms of large, massive worlds. While the asteroid belt and the Kuiper belt were each found to possess a large number of substantial icy-and-rocky worlds, none of them approached even Earth in size or mass, much less the true giant worlds. Meanwhile, all-sky infrared surveys, sensitive to red dwarfs, brown dwarfs and Jupiter-mass gas giants, were unable to detect anything new that was closer than Proxima Centauri. At the same time, Kepler taught us that super-Earths, planets between Earth and Neptune in size, were the galaxy's most common, despite our Solar System having none.

The discovery of Sedna in 2003 turned out to be even more groundbreaking than astronomers realized. Although many Trans-Neptunian Objects (TNOs) were discovered beginning in the 1990s, Sedna had properties all the others didn't. With an extremely eccentric orbit and an aphelion taking it farther from the Sun than any other world known at the time, it represented our first glimpse of the hypothetical Oort cloud: a spherical distribution of bodies ranging from hundreds to tens of thousands of A.U. from the Sun. Since the discovery of Sedna, five other long-period, very eccentric TNOs were found prior to 2016 as well. While you'd expect their orbital parameters to be randomly distributed if they occurred by chance, their orbital orientations with respect to the Sun are clustered extremely narrowly: with less than a 1-in-10,000 chance of such an effect appearing randomly.

Whenever we see a new phenomenon with a surprisingly non-random appearance, our scientific intuition calls out for a physical explanation. Astronomers Konstantin Batygin and Mike Brown provided a compelling possibility earlier this year: perhaps a massive perturbing body very distant from the Sun provided the gravitational "kick" to hurl these objects towards the Sun. A single addition to the Solar System would explain the orbits of all of these long-period TNOs, a planet about 10 times the mass of Earth approximately 200 A.U. from the Sun, referred to as **Planet Nine**. More Sedna-like TNOs with similarly aligned orbits are predicted, and since January of 2016, another was found, with its orbit aligning perfectly with these predictions.

Ten meter class telescopes like Keck and Subaru, plus NASA's NEOWISE mission, are currently searching for this hypothetical, massive world. If it exists, it invites the question of its origin: did it form along with our Solar System, or was it captured from another star's vicinity much more recently? Regardless, if Batygin and Brown are right and this object is real, our Solar System may contain a super-Earth after all.

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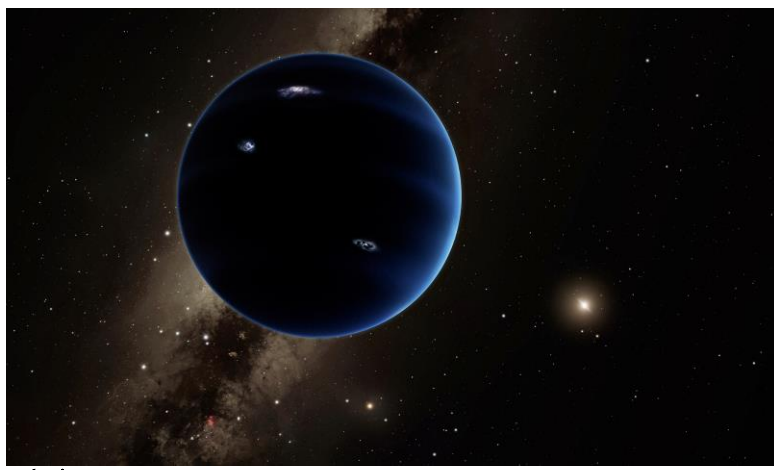
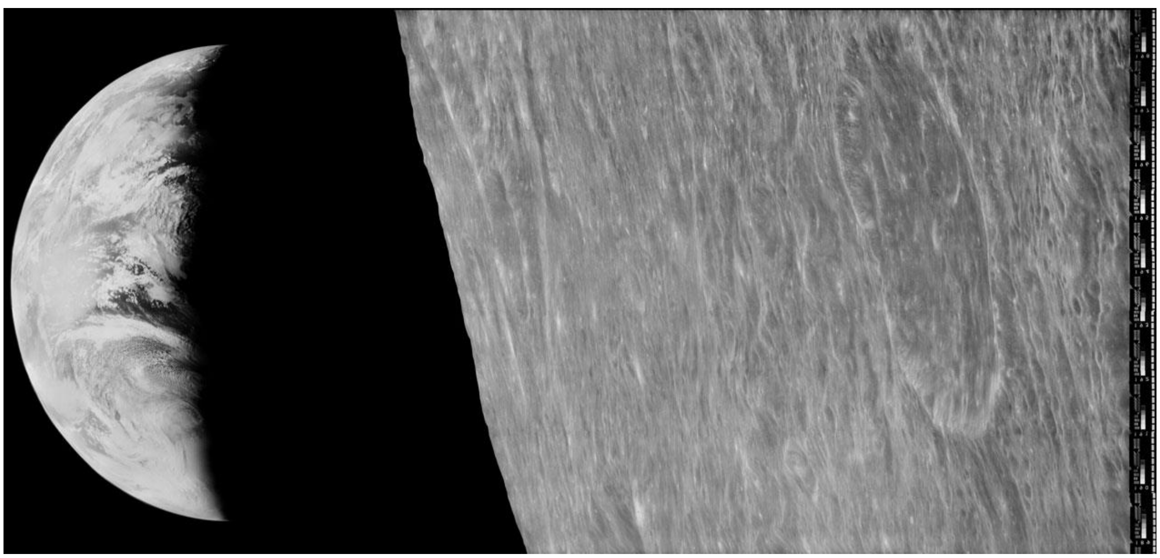


A possible super-Earth/mini-Neptune world hundreds of times more distant than Earth is from the Sun. Image credit: R. Hurt / Caltech (IPAC)

Astrophotos

Courtesy of Bob Kelly are these photos of the conjunction of Venus and Jupiter taken at the WAA Starway to Heaven event at Ward Pound Ridge on August 27^{th}. The Above Left image gives the general appearance of Venus and Jupiter in binoculars and when we could find it with the naked eye (zoom-in it's there). Bob used a Canon XS on tripod, zoom lens at 250mm, 1/250 second exposure, ISO-800. The Above Right image is an image through an 8-inch dob at prime focus with a 2x amplifier needed to bring the Canon XS to focus. Jupiter looks like a ghost image. To the eye, Jupiter did look like a ghost, but with light dark bands. Venus was smaller to the eye - the camera is overwhelmed by the brightness of Venus.



August 10^{th} was the 50^{th} anniversary of the launch of Lunar Orbiter 1. It was the first of five Lunar Orbiters intended to photograph the Moon's surface to aid in the selection of future landing sites. That spacecraft's camera captured the data used in this restored, high-resolution version of its historic first image of Earth from the Moon on August 23, 1966 while on its 16^{th} lunar orbit. Hanging almost stationary in the sky when viewed from the lunar surface, Earth appears to be setting beyond the rugged lunar horizon from the perspective of the orbiting spacecraft. Two years later, the Apollo 8 crew would record a more famous scene in color: Earthrise from lunar orbit.

Credit: APOD.

Image Credit: NASA / Lunar Orbiter Image Recovery Project