nightwatch

Newsletter of the Pomona Valley Amateur Astronomers

...with your eyes turned skyward, for there you have been and there you will long to return.
Leonardo da Vinci

Volume 31 Number 01 *nightwatch* **January 2011**

Club Events Calendar

January 21 – General Meeting James Des Lauriers

January 25 - Scout Event, Mt Baldy RV Park
January 29 – Star Party at Salton Sea.

February 9 - Magnolia Elementary, Upland, 5:30
February 10 - Board Meeting, 6:15
February 18 – General Meeting - Dave Jurasevich
February 22 – Colony Branch, Ontario Library, 6 – 8 PM

March 5 - Star Party - Mesquite Springs, Death Valley
Alternate - RAS, Landers
March 10 - Board Meeting, 6:15
March 18 – General Meeting - Dave Doody

April 2 - Star Party
April 7 - Board Meeting, 6:15
April 15 – General Meeting - Christine Pearce of Columbia Memorial Space Center
May 5 - Board Meeting, 6:15
May 6 – Wildlands Conservancy
May 7 - Star Party
May 13 – General Meeting - Albert Dicanzio PHD, "Remembering Galileo, an Astronomer's Legacy
May 14 - Girl Scout Camporee, 4:30

June 3 - Project Bright Sky - Cottonwood Springs
June 4 - Star Party - Cottonwood Springs
June 9 - Board Meeting, 6:15
June 17 – General Meeting

July 2 - Star Party
July 7 - Board Meeting, 6:15

PVAA Officers and Board

Officers
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The World's Largest Telescopes, Part 6: The 200-inch Hale Telescope

This is the sixth installment in a not-quite-monthly (sorry about that!) series covering the world's largest single-aperture optical telescopes in reverse chronological order. The last installment (Nightwatch, October 2010) was a brief survey of George Ellery Hale and his contributions to astronomy, which went well beyond building giant telescopes, although he did that as well, and frequently. The last telescope covered was the Soviet BTA-6 (Nightwatch, September 2010), a 6-meter behemoth that was probably inspired at least in part by a desire to upstage the 200-inch (5-meter) Hale telescope. The Hale telescope was the world's largest fully functional telescope for almost half a century (1948-1993) and the largest telescope outright for the first 27 years of its existence. The glass giant of Palomar also has the distinction of being the oldest former record holder still employed for research full-time (the 100-inch Hooker telescope, another of Hale's projects, is used for research but not continuously).

The conception of 200-inch telescope started shortly after the 100-inch telescope became operational in 1917. In the space of a quarter century, Hale had already increased the aperture of the world's largest telescopes by a factor of three, and their light grasp by almost nine. But he knew that a telescope larger than the Hooker was not only technologically feasible but would also be badly needed if astronomers were to solve the mysteries of the spiral nebulae and keep pushing back the boundaries of the observable universe. As early as 1921, he was discussing with Francis Pease the feasibility of a 200- or 300-inch telescope that would supersede Mount Wilson's 100-inch scope. At the same time, Hale was working every contact and connection he had to secure funding for the proposed leviathan.

The political wheeling and dealing required to even begin the project constitute a saga in their own right. Hale relentlessly petitioned the officers of the Carnegie Institution, the Rockefeller Foundation, and the National Academy of Sciences for promises of funding. In the end, the delicate arrangement was orchestrated in part by no less a personage than Elihu Root, former diplomat, statesman, and Secretary of State under Teddy Roosevelt. The Rockefeller Foundation promised six million dollars to the California Institute of Technology for a new telescope to be built in collaboration with the Carnegie-funded Mount Wilson Observatory. Carnegie partisans privately crowed that the new telescope would be built with Rockefeller money and Carnegie brainpower; their enthusiasm diminished when they learned that the new telescope would not be sited on Mount Wilson.

Times had changed, and were changing. Even in the 1920s, the growth of LA was already affecting the performance of the 60- an 100-inch telescopes at Mount Wilson. The new telescope required a new site, and a new institution to serve it. Caltech was growing from a former prep school into one of the most formidable centers of science in the Western Hemisphere--by Hale's design, and under his guidance of the university's board.

Another of Hale's savvy decisions was to hire amateur telescope maker Russel Porter to collaborate with professional telescope designer Francis Pease on the plans for the new scope. Although he argued otherwise in his progress reports and press releases, Hale knew full well that the proposed 200-inch instrument was a massive leap beyond existing telescope technology. He wanted fresh eyes on the project, those of someone who knew how to build telescopes and wouldn't be fixated on engineering solutions that had worked for the 60- and 100-inch scopes but might not work here.

The design process was not all roses. Porter did a mountain of design work, on everything from the little telescopes that would be used to assess seeing at candidate sites, to the optical lab that would be built at CalTech to polish the giant mirror. But he was an outsider among the professional astronomers and physicists of Mount Wilson and CalTech, and he had a hard time getting some of his ideas across. Porter had patented the split-ring telescope mount back in 1918, long before he was brought on the 200-inch project by Hale. His counterpart, Francis Pease, independently came up with a split-ring mount in 1921. But for the first eight years of the 200-inch project, Pease pushed an upscale of the same English fork mount he had used in designing the Hooker telescope. By 1934 it was clear that the English fork was not going to work; not only was a simple upscale untenable from an engineering standpoint, it was also ill-favored by astronomers because it blocked the mounted telescope from pointing to the stars near the celestial pole. No one wanted what was already clearly going to be a generation-defining instrument to have a blind spot. Opinion shifted in favor of Porter's horseshoe-shaped ring mount, but Pease was generally credited with the novel design, thanks to his early-1920s sketches, and much to Porter's disgust.

There were other problems, none of them trivial. A mechanical system of levers and counterweights would have to be designed to keep the massive mirror from deforming under its own mass. The casting of the disk itself was fraught with problems, as engineers at Corning struggled to perfect the pouring and annealing of so much Pyrex--the first time the new material had ever been used for a telescope mirror. A series of test blanks were poured, and the 120-inch blank was later brought out of storage and sold to the University of California's Lick Observatory, where it became the primary mirror of the Shane reflector, itself among the world's largest telescopes in the mid-20th century. The Great Depression slowed work on the telescope, and the entry of the United States into World War II stopped it entirely. At CalTech, the only partially-completed primary mirror was put in storage to await the end of the war.

When the war ended, the last major job was the finishing of the optical surface. The dome on Palomar Mountain had been finished and waiting since before the war. The great horseshoe mount was in place, so perfectly balanced that a milk bottle set on one side of the mount would set its hundreds of tons to slowly rotating. At the optical lab in Pasadena, eleven and a half years of grinding and polishing had consumed 31 ton of abrasives.

Although the 200-inch telescope saw first light early in 1948, it was not turned over to the astronomers for regular observations for almost a year. The intervening time was occupied with finessing the mirror supports and working away the last imperfections on the mirror. The final touches were literally touches: the opticians worked down from 12-inch

200-inch Hale continued

polishing tools to gentle swipes with a rouge-covered human thumb. After a handful of strokes the mirror had to be set aside to regain its thermal equilibrium, minisculely but critically disturbed by a few seconds' contact with a single living digit, before it could be tested.

Hale had died in 1938, a full decade before the telescope he dreamed--and cajoled, threatened, and sweated--into existence was complete. There was never any serious doubt but that it would be named after him. The Hale telescope was the Keck and Hubble combined for an entire generation of astronomers, and it continues to be used for groundbreaking work today. Most of the newer and all of the larger observatory telescopes use lighter, more compact alt-azimuth mounts. The sheer heft of the massive equatorial mount of the 200-inch telescope makes it an unusually solid platform for testing new instruments. It is still in the top twenty largest optical telescopes in the world, and with any luck it is only in the middle of its distinguished--indeed, legendary--career.

Much of what I related here is drawn from The Perfect Machine, by Ronald Florence, which includes innumerable stories that I did not have room to include. It's an outstanding book, and I recommend it to anyone with an interest in the evolution of observatory telescopes.

For more information on Hale and his telescopes, please see CalTech's page on the history of the Palomar Observatory (http://www.astro.caltech.edu/palomar/history.html).

Mathew Wedel

How Does It Work?

Cottonwood Springs is one of the darkest sites available to us in Southern California. But sometimes the "seeing" is better than other times. In a dark desert site there are two main contributors, dust and humidity. A Canadian weather service provides a "Clear Sky" chart for California for the next 36 hours at http://www.cleardarksky.com.

Data is presented in a chart form by the hour for: cloud cover, transparency, seeing, darkness, wind, humidity and temperature. All of these factors are compiled by Clear Sky into the "seeing" chart. Let's look at just two of them, clouds and humidity.

Note that wind, humidity and temperature are only given for ground level. These all affect how good the night will be. But temperature, humidity and winds aloft (above ground level) can seriously affect seeing also. Cloud cover is obvious. If there are clouds, the seeing is limited. But, depending on the type of clouds it can indicate the amount of humidity aloft. That is additional information not provided by the humidity at ground level.

The temperature drops as altitude increases. When the dew point is reached, the water precipitates out. That tells us that on a cold night the air aloft may reach a dew point even though the air at ground level still has a moderate humidity. In fact, the dew falling from altitude may make things worse at ground level. On the other hand, if the air is particularly dry at ground level, the drying out of the air above may make the seeing better.

The cause of the humidity is important. If a recent rain is the culprit, things don't tend to improve as the temperature drops. But if the condition is dry at ground level with high altitude clouds, the lower temperature can make the seeing improve significantly. Winds aloft may clear the clouds or make them worse.

It isn't necessary to wait until the day before a star party to start planning the evening. The internet provides a lot of information which can assist in predicting what the conditions will be. Weather.com gives a 10 day forecast. Weather maps will indicate what the future may look like.

When a chance of precipitation is indicated, the air will likely be near saturation and the seeing will be poor. But if the ground has been dry under a good sun for several days, scattered clouds may allow good viewing. Clear skies are associated with a high pressure area. As the high passes to the east, the end of the high will be better than the beginning.

There are many things we can plan to do depending on the seeing conditions. On a perfect night, the faint fuzzies can become the objective. On a poor night, maybe the plan will simply be to improve the skill of star hopping by using binoculars and a star chart.

Understanding the complexities of the weather forecast can be quite helpful in planning a fun star party. I'm only disappointed when I have false expectations.

Ken Crowder

What's Up? A Big Belt On The Equator

Some constellations are well known by the general public. One is a circumpolar group The Big Dipper (Ursa Major), which is always visible because it wheels around the North Star. It appears on the flag of Alaska. The southern circumpolar group is the Southern Cross (Crux) which appears on the flags of five nations. But the constellation Orion is famous even though it isn't in the always visible circumpolar position. Its big belt passes right above the equator, and it looks like the giant it's supposed to be. Throughout history Orion has been seen as a great masculine figure by a majority of cultures He's a mighty hunter who fights Taurus (the Bull, just above him) and also Scorpius (the Scorpion, banished beyond the horizon). Scorpius and Orion are never in the sky at the same time. Mythology has separated them to put a stop to their ongoing battle.

I'd bet on Orion, his companions are two hunting dogs (Canis Major and Canis Minor) who follow him across the sky. Beneath his feet cowers the hunter's prey, a rabbit (Lepus). He's obviously a powerful outdoor type.

But even more remarkable than his handsome hourglass figure is his belt of three impressively lined up stars. But they are not as close as they appear. In rising order from west to east they are Mintaka (915 light years), Alnilam (1,340 ly), and Alnitak (800 ly). Alnilam is almost twice as far away as the two blue giant stars on either side of it, and it's a blue super giant. All three tongue twisting names are Arabic and refer to a belt or girdle. The three are mentioned several times in the Bible and many other ancient texts. Other names are The Three Kings, The Three Marys, or The Three Pearls. The Yokut Indians of California called them the Footprints of the Flea People. It explained why fleas weren't active in the winter time.

On Orion's higher shoulder lies a famous red super giant, Betelgeuse (640 ly). Its odd Arabic name means armpit. It's expanded through the ages to over 300 times the size of the sun, and is one of the larger stars in the sky. It was the first star outside the solar system to have its diameter measured.

In a comic movie BEETLEJUICE the title character was an wildly unpredictable demon. Betelgeuse is just as full of odd surprises. Its unstable variability was first seen by John Herschel in 1849. Recent studies have shown it to be bleeding mass into a stellar atmosphere which might hide small companion stars. Its unstable size will probably cause it to explode into a dazzling supernova some day. Wild prophecies have it blowing on December 21, 2012 in keeping with a Mayan end of days prediction.

On the opposite corner of Orion, at 700 light years distant is an even brighter blue super giant, Rigel (foot). It's 85,000 times the luminosity of the sun and has two companions. Two other blue giant stars form Orion's chunky figure. The first is Saiph (2,100ly) at his other foot. It's large but because it's so extremely hot it emits visibly fainter ultraviolet radiation. In the other shoulder is the only star in Orion with a non Arabic name. It's called Bellatrix and means a beautiful female warrior. It's called the Amazon Star and seems to be Orion's feminine side. This brings us to a famous fuzzy thing between Orion's legs.

Hanging from his belt is Orion's "sword" which contains the dazzling Great Orion Nebula (M42). It's 24 light years wide and 1,350 ly away. Because it is visible to the naked eye this spectacularly illuminated nebula was noticed by even pre-telescopic cultures. The Mayans called it a celestial campfire. It was first observed by astronomer Pieresc's telescope in 1610 along with its internal open star cluster now called The Trapezium. Galileo remarked on the cluster but not on the nebula. There is no mention of the nebula before the 17th century. This may suggest that the nebula was darker then and has grown brighter since. Charles Messier sketched and catalogued it as M42 in 1774. It became the first object of deep-sky astrophotography in 1880. It is the most photographed of deep sky objects. Famous astronomers have called it "a great ghostly bat" and "a vision of primeval chaos." The poet Tennyson called it a "vast charm…to make fame nothing." For amateur telescopes it is the perfect deep sky object. Its protoplanetary disks and red dwarf stars have revealed how planetary systems and stars are formed from gas and dust.

It is part of a larger Orion Molecular Cloud Complex. Besides M42, the Complex contains the fainter nebulae M43, M78, Barnard's Loop, the Witch Head Nebula, the Flame Nebula, and the famous Horsehead Nebula. This chess piece silhouette was first noticed in a photographic plate in 1888. It's dark dust cloud form stands out against gas ionized by the nearby sword star Sigma and the beacon belt star Alnitak. It's large, but very difficult to see in a smaller telescope without filters and long photographic exposure

So Orion is a mighty hunter who stands astride the equator. A hunter inside of whom much satisfactory deep sky hunting can be done.

Lee Collins