The High Desert Observer

November 2018

The Astronomical Society of Las Cruces (ASLC) is dedicated to expanding public awareness and understanding of the wonders of the universe. ASLC holds frequent observing sessions and star parties and provides opportunities to work on Society and public educational projects. Members receive the *High Desert Observer*, our monthly newsletter, plus membership to the Astronomical League, including their quarterly publication, *Reflector*, in digital or paper format.

Individual Dues are $30.00 per year

Family Dues are $36.00 per year

Student (full-time) Dues are $24.00

Annual dues are payable in January. Prorated dues are available for new members. Dues are payable to ASLC with an application form or note to: Treasurer ASLC, PO Box 921, Las Cruces, NM 88004. Contact our Treasurer, Patricia Conley (treasurer@aslc-nm.org) for further information.

ASLC members receive electronic delivery of the HDO and are entitled to a $5.00 (per year) Sky and Telescope *magazine discount.*

ASLC Board of Directors, 2018

Board@aslc-nm.org

President: Howard Brewington; President@aslc-nm.org

Vice President: Rich Richins; VP@aslc-nm.org

Treasurer: Patricia Conley; Treasurer@aslc-nm.org

Secretary: John McCullough; Secretary@aslc-nm.org

Director-at-Large: Steve Barkes; Director1@aslc-nm.org

Director-at-Large: Ed Montes Director2@aslc-nm.org

Past President: Chuck Sterling; csterlin@zianet.com

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Grants: Sidney Webb; sidwebb@gmail.com
Loaner Telescope:Sidney Webb; sidwebb@gmail.com
Membership: Open
Observatories:
Leasburg Dam: David Doctor; astrodoc71@gmail.com
Tombaugh: Steve Shaffer, sshaffer@zianet.com
Outreach: Chuck Sterling; csterlin@zianet.com
Web-Site: Steve Barkes; steve.barkes@gmail.com
HDO Editor: Charles Turner; turner@milkywayimages.com

Masthead Image: February 10, 2017 From Las Cruces, Moon rising over the Organ Mts in Penumbral Eclipse.

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November Meeting --

Our next meeting will be on ***Friday, November 16***, at the Good Samaritan Society, Creative Arts Room at 7:00 p.m.

The speaker will be Steve Woods and the topic will be "Planetary Imaging".

Member Info Changes

All members need to keep the Society informed of changes to their basic information, such as name, address, phone number, or emai address. Please contact Treasurer@aslc-nm.org with any updates.

Events

ASLC hosts deep-sky viewing and imaging at our dark sky location in Upham. We also have public in-town observing sessions at both the International Delights Cafe (1245 El Paseo) and at Tombaugh Observatory (on the NMSU Campus). All sessions begin at dusk.

At our Leasburg Dam State Park Observatory, we hold monthly star parties. Located just 20 miles north of Las Cruces, our 16" Meade telescope is used to observe under rather dark skies.

Please see *Calendar of Events* for specific dates and times.

What's Up ASLC?

***November* 2018**

It's an unfortunate fact that astronomy clubs come and go; however, the Astronomical Society of Las Cruces has realized yet another year of longevity in 2018. Our club came to be in 1951 with the coordination of Clyde Tombaugh, the discoverer of the planet Pluto, and nineteen other local amateur astronomers. Their mission: "Provide an opportunity for astronomers and the general public to enjoy and learn about the wonders of the night sky." Their goal: "Scientific, Educational, and Recreational activities." In the beginning, the ASLC's monthly meetings were held at club members' homes. But, as the club's roster grew, larger venues were necessary, which included the Las Cruces School District offices and later the New Mexico State University Campus. Although Clyde was the club's first president, many other individuals have followed in the footsteps of his leadership over the past sixty-seven years. During 2017 and 18, the ASLC board members and I assumed the leadership responsibility of our club. We, of course, maintained club traditions, but also we made a few adjustments.

With business as usual, ASLC has continued our monthly Moon Gazes, but we're now offering this event in two locations, i.e., International Delights and the Pan Am Plaza. We also manned our observatory schedules at NMSU and Leasburg Dam State Park. And, as a new ASLC offering for the general public, we sometimes provide astronomy-related twilight presentations at Leasburg. Our Renaissance Faire exhibits successfully advertise the ASLC and provide hundreds of faire-goers the opportunity to use a telescope. With the help of volunteers, ASLC has continued to produce a wonderful monthly newsletter, and we've maintained our award-winning website. Our annual Star-Party Review in June now includes TSP, the Cosmic Campground, and Rusty's RV Park. And, we're now doing an astro-imaging contest to showcase club members' incredible expertise.

During the last two years, ASLC received several generous donations. Some of that cash was used to upgrade the video projector that we use at each monthly meeting. We also maintained our club-apparel inventory, and we increased security at the Leasburg observatory with an alarm system, installed by club members. To free up some additional cash, the ASLC Board and I made a few financial adjustments to our monthly expenses. Some of that surplus was used to purchase small trophies for our annual astro-imaging contest, and we treated several guest speakers to dinner before our meetings. Following our meetings, we now get together at the Pecan Grill for refreshment and additional fellowship.

With projects on the horizon, ASLC is working with NM Park authorities to maintain the exterior of the Leasburg observatory. We're also in discussion with them about adding concrete observing pads for additional scopes. We have cash in our Leasburg account, and we're currently researching the cost to upgrade the observatory's computers and telescope-control software. After the new hardware's installed, we plan to back up the computer's hard drive in case of an emergency. I'm sure Clyde would be VERY proud of the dedication provided by the ASLC membership. Likewise, I feel certain that the club's enthusiasm will continue for many years. I wish the ASLC and president-elect Tracy Stuart all the best in 2019, and it's been my honor to be your president these past two years.

Howard J. Brewington, ASLC President November 2018

* * *

Outreach
Outreach is a very important part of ASLC. We are always looking for more volunteers to help us educate the public. Even if you do not have a portable telescope to bring to the events, please consider attending our public outreach programs to help answer questions, share knowledge and point out objects in the sky.

Outreach Events

2018 October Report

by Jerry McMahan

Rockhound State Park, Saturday October 6

Weather was good. We had a good crowd of about 35 people. Bill Nigg did the presentation and somebody dropped $5 in the tip jar. Mike Nuss went on vacation and Charles Turner showed up to help with telescopes..

Moongaze, Saturday, October 13

Howard Brewington, Steve Wood, Chuck Sterling and Jerry McMahan went to the International Delights for this months Moongaze. We came, we looked, we saw clouds, we drank coffee.

City of Rocks SP, Saturday, October 13

It was very cloudy, all day. In fact, at 10 am the ranger called and asked if we should cancel. I suggested we wait until later in the afternoo to decide. At 3 pm, I called him to cancel.

Tombaugh Observatory, Friday, October 19

I was sick and missed the first event that I have missed in a long time. Steve Shaffer saved the day by manning the 12.5 inch scope on his own. He had done that before, but I wished that he had more help. I did see the sky was partly cloudy and could see the Moon. I assume there were enough planets visible to give a number of targets. I haven't heard from Steve yet, but would bet that the night was a success.

UPDATE: Steve Wood also attended. He said the clouds moved in quickly. I did a time exposure video and said that the clouds even changed direction, but directions did not produce clear skies. The event was canceled.

Mayfield High School, Monday, October 29

On Monday October 29th, about 15 – 20 Physics students from Mayfield High School attended a Solar viewing event at the school for the class of Melissa Delaurentis by ASLC with Howard Brewington, Mike Nuss, Steve Woods, Chuck Sterling, and Sid Webb, who also provided a short introduction to Solar physics. Unfortunately, there were exactly zero sunspots visible, although some of the H-alpha scopes may have spotted a few small flares along with showing the texture of the solar atmosphere. The students each had a notebook with which to take notes, and several were doing sketches of what the were seeing. From the white-light scopes they were drawing blank circles, with a bit of shimmer and chromatic aberration on the edges. We suggested that we should do this again in about 5 years, when the sunspots come back.

Leasburg, Saturday, November 3

Dave Doctor operated the observatory. I attempted to assist. Chuck Sterling helped Steve Wood fix a problem with the 11 inch Celestron telescope. It was a clear night. Clouds did start to move in close to quitting time. The session went well, but it was the fewest number of club participants ever at this location.

Rockhound State Park, Saturday November 3

Weather was OK. We had about 25 people, Bill Nigg did the presentation. Mike Nuss returned from vacation with his TV 101 and Charles Turner showed up with his new Quantum 6. The crowd was very engaged and asked good questions. Somebody dropped $2 in the tip jar.

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Calendar of Events (Mountain Time - 24 hr. clock)

Nov	01	18:17	Sun Sets
	03	10:00	OUTREACH, Renaissance Faire, 10 -5
	03	18:00	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	03	18:15	OUTREACH; NPO Presentation at Rockhound S P, B. Nigg, M. Nuss, C. Turner
	04	10:00	OUTREACH, Renaissance Faire, 10 -4
	04	02:00	Daylight Saving Time Ends
	07	09:02	New Moon
	08	18:00	OUTREACH; Desert Springs Christian Academy, 6:30 - 8:30 pm
	10	17:00	OUTREACH; NPO Presentation at City of Rocks SP, B. Nigg, C. Turner, K. Brown
	11	02:00	Daylight Saving Time begins
	14	11:00	OUTREACH: Solar Viewing, Sagecrest Park for Home School group; 11am to 2 pm
	15	07:55	First Quarter Moon
	15	18:00	OUTREACH: Veterans Park, Home School Star Party
	16	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room
	16	19:00	OUTREACH; Tombaugh Observatory open at NMSU; 7 -8 pm
	17	18:30	OUTREACH; MoonGaze, International Delights Café
	17	18:30	OUTREACH; MoonGaze, Pan Am Plaza on University Ave
	22	12:01	Thanksgiving - All Day
	22	22:40	Full Moon
	29	17:19	Last Quarter Moon
Dec	01	17:02	Sun Sets
	01	19:00	Saturn Set
	01	23:52	Mars Sets
	01	12:00	OUTREACH; Set Back the Sun Winter Solstice Event at Leesburg Dam State Park

01	17:02	OUTREACH; NPO Presentation at Rockhound SP, B. Nigg, M. Nuss, C. Turner
07	12:21	New Moon
07	19:00	OUTREACH;Tombaugh Observatory Open House: 7:00 to 8:00 PM
08	17:00	OUTREACH; NPO Presentation at City of Rocks SP, B. Nigg, C. Turner, K. Brown
08	00:00	ASLC Christmas Party: TBA
15	04:50	First Quarter Moon
15	17:00	OUTREACH; MoonGaze, International Delights Café
15	17:00	OUTREACH; MoonGaze, Pan Am Plaza on University Ave
22	10:48	Full Moon
25	00:00	Christmas - All day
29	02:35	Last Quarter Moon
29	17:00	OUTREACH; Dark Sky Observing at Leesburg Dam State Park

Be sure to visit our web site for ASLC information: *www.aslc-nm.org*

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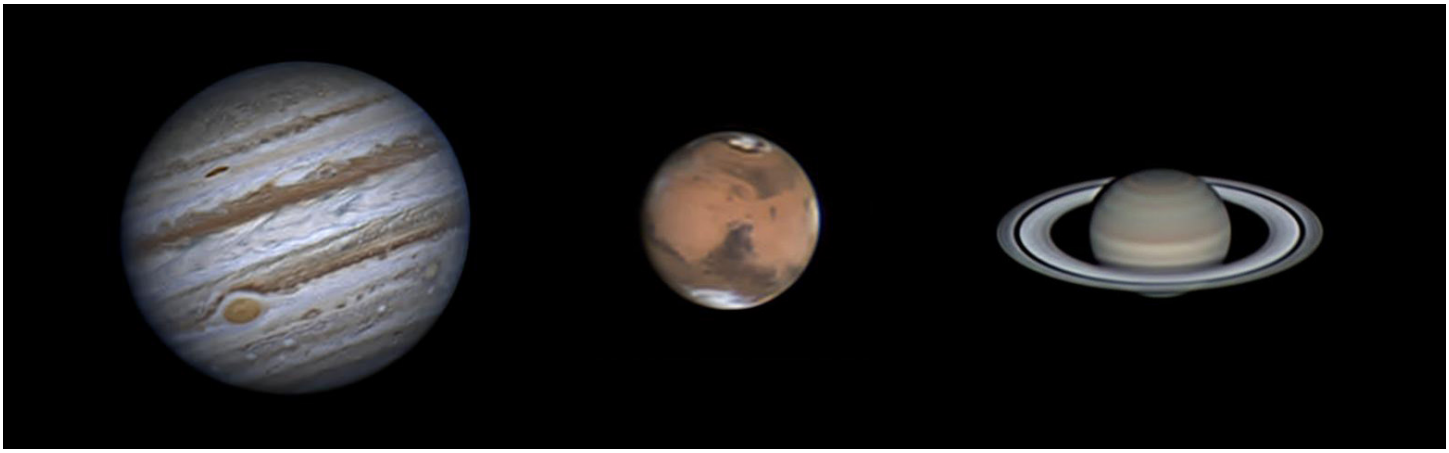
Announcements

1. The program for the November meeting will be a presentation by Steve Woods on Planetary Imaging. He will compare planetary imaging to DSO imaging and also how a visual observer can give it a try even without a tracking scope. The presentation will be using some of the information from the website here:
http://planetaryimagingtutorials.com/



Planetary images taken by Steve from his driveway in Orlando.

2 Please note that the November ASLC monthly meeting has been moved to the third Friday, Nov 16, to avoid conflict with feasting and revelry.

3. The ASLC will not have a usual meeting in December. Instead, we will have a Christmas Potluck Meal and informal gathering. The Christmas gathering will be held on December 8th. The time, location and theme for the potluck will be announced at the November meeting.

4. The HDO will not be published in full in December. Everybody needs a rest. I may send out a shortened HDO with a Holiday Greeting from one of our fearless leaders and a Calendar for January.

5 The agreement to use the facilities at Good Sam for our meeting prohibits members from bringing in ANY food or beverages, except water in a container with a screw lid. Take note: no more Starbucks or Saturn Cookies!

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Meeting Minutes
ASLC Monthly Meeting
October 2018 Minutes

Call to Order:

Howard Brewington, President, Astronomical Society of Las Cruces (ASLC, the Society), called the October 2018 business meeting to order at 7:00 pm, 26 October 2018, Creative Arts Room, Good Samaritan Society Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, New Mexico.

President's Comments:

Howard Brewington, President, welcomed the group to tonight's meeting. He asked all members and any visitors to sign in on the rosters at the rear of the room. He welcomed Roger Chacon from El Paso. Roger has just ordered a telescope and is looking for pointers in setting it up. He has property in the Cloudcroft area and is thinking about joining the Society tonight.

Gary Starkweather presented a video he made of the Society field trip to the Mt. Graham International Observatory (MGIO) in September. It was very informative and enjoyable, and Gary encouraged members to visit the MGIO if they get an opportunity.

Howard thanked Charles Turner for the October issue of the High Desert Observer (HDO). Charles pointed out that he needs to revise Jerry McMahan's article as some of the mathematical formulas got scrambled. He also thanked Chuck Sterling for his image submissions.

The minutes of the September meeting were published in the HDO. If no corrections or discussion are required, Howard asked that the minutes be accepted as submitted; they were accepted by acclamation.

Treasurer's Report:

Trish Conley, Treasurer, had a summary of the Society's finances available at tonight's meeting. She also had a comparison of income and expenditures for 2018 vs. 2017 available.

Loaner Telescope Program

Sid Webb, Program Coordinator, brought a Celestron C8 that is in the program. He feels it has not been used because of the need for a substantial tripod and mount. He has converted it to a more portable table-top mount. He still has issues with the finder scope (and would like input from members) but demonstrated an option using his I-phone and Sky Safari app.

2018 2019 Elections Committee:

Election of Officers for 2019 was held tonight. The nominating committee: Tracy Stuart (Chair), Tim Kostelecky, and Trish Conley, put together a slate of candidates to stand for office. Since Tracy and Trish agreed to be candidates for 2019, they were replaced by Rich Richins and Bert Stevens as election tellers. Following tabulation of the ballots received or submitted, Officers for 2019 are as follows:

President:	Tracy Stuart
Vice-President:	Ed Montes
Secretary:	John McCullough
Treasurer:	Trish Conley

Director-at-Large #1: Steve Barkes
Director-at-Large #2: Kevin Brown

Howard Brewington will continue to serve on the Board of Directors as Immediate Past President.

Renaissance Arts Faire 2018:

Trish Conley is organizing the Society's participation in this year's Faire to be held 03 04 November at Young Park. So far, only a few members have volunteered to assist with set-up on Friday, 02 November, manning the booth in costume on Saturday and Sunday, 03 04 November, and tear-down on Sunday. If additional members do not commit to support this event, the Society may have to withdraw. Contact Trish as soon as possible if you can help in any way. This is a major outreach opportunity for the Society.

Astronomical League (AL):

Ron Kramer is currently serving as Vice President and acting President of the AL. The AL has published a calendar for 2019 that has extensive astronomical and AL information included. Cost is $13 per calendar (the same price as the Planetary Society calendar). Ron has several calendars with him tonight and if members are interested can provide additional copies.

Presentation:

This month's presentation was by Society member Dr. Bill Stein, "What is AAVSOnet and How You May Use It". The AAVSOnet is a dispersed, shared robotic telescope network operated by the AAVSO. Bill explained how members and non-members may submit proposals for an observing program on variable stars to the AAVSO Bright Star Section.

Bill also noted that the Section is proposing that the Fall 2019 meeting of the AAVSO be held at New Mexico State University (NMSU) on 25 26 October 2019. The meeting will cover several topics and volunteer help from the community is desired and encouraged.

The November 2018 Monthly meeting will be held on 16 November to not conflict with the Thanksgiving holiday.

The October meeting of the Astronomical Society of Las Cruces concluded at 8:20 pm. A social time followed at Pecan Grill.

-Respectfully submitted by John McCullough, ASLC Secretary

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Visiting the Mount Graham International Observatory

On September 22, 2018 a group from the Astronomical Society of Las Cruces toured the Mount Graham International Observatory (MGIO). All the members and guests were from the Deming area. Unequivocally, I think it can be said that all of us had a wonderful, amazing and pleasant experience.

The MGIO is a division of Steward Observatory, the research arm for the Department of Astronomy at the University of Arizona. There are three research telescopes located at MGIO: Vatican Advanced Technology Telescope; Submillimeter Telescope; and The Large Binocular Telescope. The facility is in the Pinaleno Mountains, part of the Coronado National Forest. It is situated on the summit, Mount Graham (or High Peak), at 10,700 feet in elevation. Eleven Universities and research consortiums use the facilities.

The tours are arranged and conducted by the Eastern Arizona College, Discovery Park Campus located in Safford, Arizona. Upon arriving at 9:00 a.m. you are introduced to the College staff and the tour guides and then a brief presentation of what the MGIO is about. Also, there is a discussion of the site location selection and the importance of being respectful while visiting the site. The mountain is sacred to the San Carlos Apache Tribe and environmentally sensitive due to the Mount Graham red squirrel. Tours begin in mid-May and go through October. Because permits are required to enter the endangered red squirrel refugium, reservations are required.

After the introduction and boarding clean, newer vans you are driven up the mountain with information of the mountain and it's access by the guides via an intercom system. Before reaching the observatories, you stop and have lunch at Columbine Ranger Station, then proceed to the site. After visiting the observatories, you are driven back down the mountain and arrive back at the College around 4:00 ~ 5:00 p.m.

The Submillimeter Telescope

The Submillimeter Telescope (SMT), formerly known as the Heinrich Hertz Submillimeter Telescope, is a submillimeter wavelength radio telescope located on Mount Graham, Arizona. It is a 10-meter-wide parabolic dish inside a building to protect it from bad weather. The building front doors and roof are opened when the telescope is in use. The telescope's construction was finished in 1993. Along with the 12 Meter Telescope on Kitt Peak, this telescope is maintained by the Arizona Radio Observatory, a division of Steward Observatory at the University of Arizona.

The dryness of the air around and above Mt. Graham is particularly vital for EHF (extremely short wavelength radio) and far-infrared observations - a region of the spectrum where the electromagnetic waves are strongly attenuated by any water vapor or clouds in the air.

This telescope is used nine-to-ten months of the year, and it is stowed only when there is too much water vapor in the atmosphere, primarily during the summertime. Of note, this was the test bed of having the telescope and building rotate together, now used by designers on most all very large telescopes!

Vatican Advanced Technology Telescope

The 1.8-meter Alice P. Lennon Telescope and its Thomas J. Bannan Astrophysics Facility, known together as the Vatican Advanced Technology Telescope (VATT), is a Gregorian telescope observing in the optical and infrared. It achieved its first light in 1993. The heart of the telescope is an f/1.0

VATT: *The Vatican Advanced Technology Telescope, aka The Pope's Telescope..*

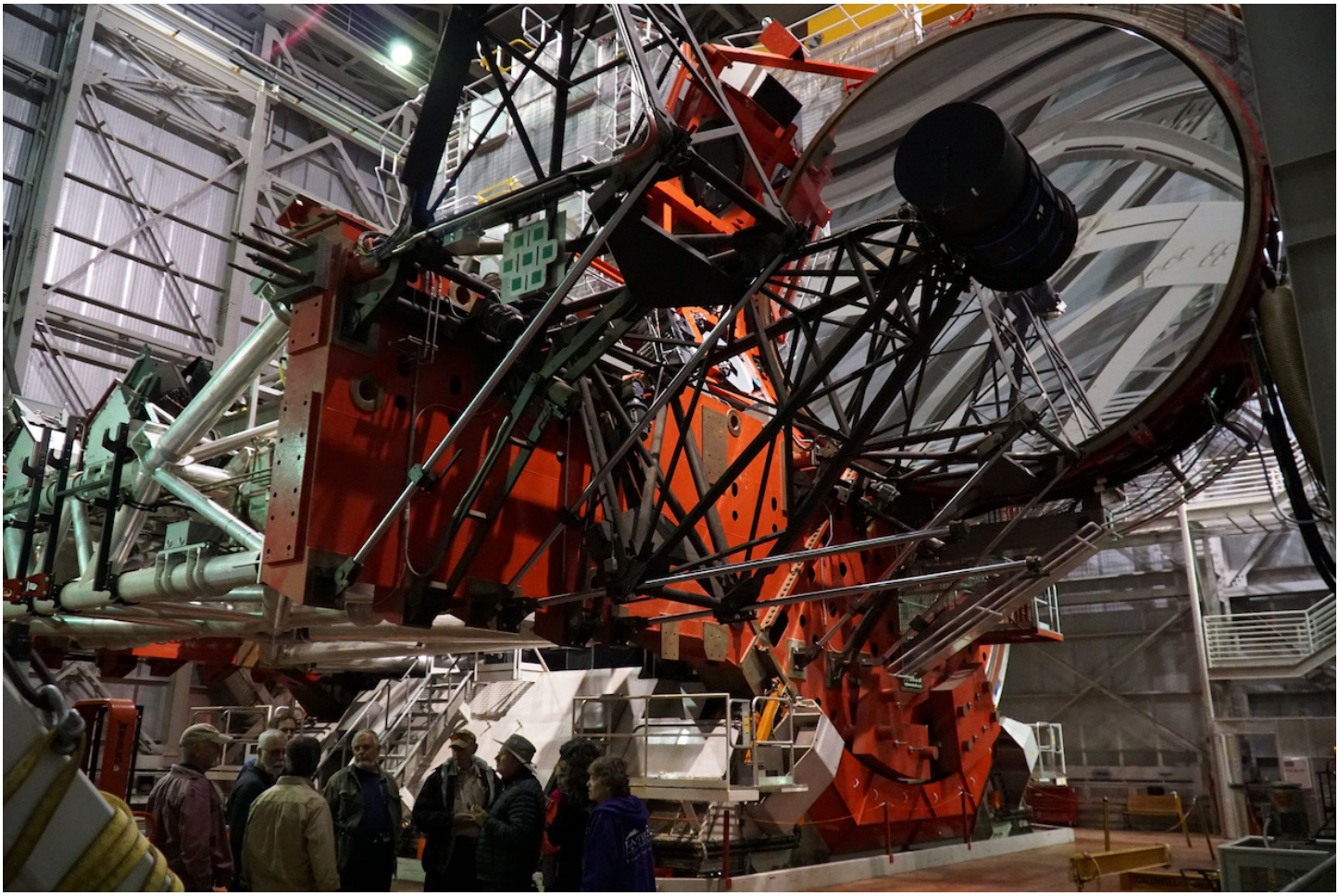
honeycombed construction, borosilicate primary mirror. The VATT's mirror is unusually 'fast', f/1, which means that its focal distance is equal to its diameter. Because it has such a short focal length, a Gregorian design could be employed which uses a concave secondary mirror at a point beyond the primary focus; this allows unusually sharp focusing across the field of view.

The unusual optical design and novel mirror fabrication techniques mean that both the primary and secondary mirrors are among the most exact surfaces ever made for a ground-based telescope. In addition, the skies above Mount Graham are among the most clear, steady, and dark in the continental North America. Seeing of better than one arc-second even without adaptive optics can be achieved on a regular basis. The primary mirror was manufactured at The University of Arizona's Steward Observatory Mirror Laboratory, which pioneered both the spin-casting and the stressed-lap polishing techniques which are being used for telescope mirrors that include the 6.5-meter aperture MMT and Magellan telescopes, and the two 8.4-meter mirrors of the Large Binocular Telescope.

The Large Binocular Telescope

I didn't know what 8.4 meant till I stood in front of 8.4

The LBT was originally named the "Columbus Project". It is a joint project of these members: the Italian astronomical community represented by the Istituto Nazionale di Astrofisica, the University of Arizona, University of Minnesota, University of Notre Dame, University of Virginia, the LBT Beteiligungsgesellschaft in Germany (Max Planck Institute for Astronomy in Heidelberg, Landessternwarte in Heidelberg, Leibniz Institute for Astrophysics Potsdam (AIP), Max Planck Institute for Extraterrestrial Physics in Munich and Max Planck Institute for Radio Astronomy in Bonn); The Ohio State University; and the Research



8.4 Meters: One of the two 8.4 meter telescopes.*The ants in the forground are provided for scale!!*

Corporation for Science Advancement based in Tucson, AZ. The cost was around 100 million Euro. The telescope design has two 8.4-meter (28 ft) mirrors mounted on a common base, hence the name "binocular". LBT takes advantage of active and adaptive optics, provided by Arcetri Observatory. The collecting area is two 8.4-meter aperture mirrors, which works out to about 111 m2 combined. This area is equivalent to an 11.8-meter (39 ft) circular aperture, which would be greater than any other single telescope, but it is not comparable in many respects since the light is collected at a lower diffraction limit and is not combined in the same way. Also, an interferometric mode will be available, with a maximum baseline of 22.8 meters (75 ft) for aperture synthesis imaging observations and a baseline of 15 meters (49 ft) for nulling interferometry. This feature is along one axis with the LBTI instrument at wavelengths of 2.9–13 micrometres, which is the near infrared.

The telescope was designed by a group of Italian firms and assembled by Ansaldo in its Milanese plant, dissembled, then shipped to the United States.

In binocular aperture synthesis mode LBT requires a beam combiner that was tested in 2008 but has not been a part of regular operations. It can take images with one side at 8.4 m aperture or take two images of the same object using different instruments on each side of the telescope.

In the summer of 2010, the "First Light Adaptive Optics" (FLAO) – an adaptive optics system with a deformable secondary mirror rather than correcting atmospheric distortion further downstream in the optics – was inaugurated. Using one 8.4 m side, it surpassed Hubble sharpness (at certain light wavelengths), achieving a Strehl ratio of 60–80% rather than the 20–30% of older adaptive optic systems, or the 1% typically achieved without adaptive optics for telescopes of this size. Adaptive optics at a

telescope's secondary (M2) was previously tested at MMT Observatory by the Arcetri Observatory and University of Arizona team.

The LBT cleans and aluminizes one of the mirrors, in place each year! While we were there, they had just completed that task on the right mirror (left if facing the telescope head on). We could stand and ogle the untouched mirror during our visit. I didn't know what 8.4 meant till I stood next to it. The camera/instrument portals at the base of the scope are the size of my living room.

Again, learning from the submillimeter telescope building concept, watching the whole building/telescope turn effortlessly leaves one amazed. The structure rides on a train track system via variable frequency drive motors, sitting on top of a truly massive pedestal. Construction photos and timeline in the main entrance foyer shows how all of this came to be. Wow.

If you visit Mount Graham International Observatory, please plan on an all-day trip. At nearly 11,000 feet in elevation, there can be strong winds at times, and noticeably cooler than the desert floor. The road is typical of most smaller mountain roads- winding and winding, but very much worth the effort. With knowledgeable and pleasant tour guides, in my humble opinion, worth the $35 or $40 fee.

Mike Nuss
Deming
Reporting, Sunday, November 4, 2018

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The Uranograph - November 2018.
By Bert Stevens

Constellation of the Month: Pegasus, The Winged Horse.

This month our Constellation of the Month is a flying horse, Pegasus. This constellation's main visual feature is the square, made up of four bright stars. These are commonly referred to as "The Great Square of Pegasus". Unfortunately, the northeast (upper left) star of the Great Square actually belongs to the constellation Cassiopeia. Even so, the Great Square remains "of Pegasus".

Pegasus is the famed winged horse from Greek mythology seen in many tales of the ancient world. Pegasus came to be when Perseus beheaded the Gorgon Medusa and a few drops of her Medusan blood fell upon the white sea foam, giving rise to the blazingly white stallion and his glorious wings. Perseus put Medusa's head in his bag, and sitting atop Pegasus, Perseus set off to win the Andromeda from the evil sea monster Cetus. After aiding Perseus, Pegasus was set free to roam the world, and carry thunderbolts for Zeus.

Pegasus means "spring", and wherever his hoofs fell touched the earth, an inspirational spring of water would appear. He is responsible for the famed in fountain of Hippocrene on Mount Helicon. Because of this, he is associated with the Muses and poetic inspiration.

Meanwhile, Bellerophon was the grandson of Sisyphus, an arrogant man who was punished by the gods by being forced to roll a bolder up a hill only to have it roll back down just before reaching the top and having to do it all over again. Bellerophon found out where Pegasus was and while the winged horse drank from the Pierian spring, Bellerophon slipped a golden bridle given to him by Athena over Pegasus's head and tamed the wild stallion.

Bellerophon and Pegasus fought a number of battles, including those against the Chimera, who had the head of a lion, the body of a goat, and the tail of a snake. He also fought the Amazons. But like his grandfather, Bellerophon became arrogant and tried to ride Pegasus up to Olympus. Zeus quickly put a stop to this mere mortal by causing an insect to sting Pegasus, who threw Bellerophon off his back. Bellerophon fell back to earth and lived, but was crippled and blinded in the fall. He died a lonely and miserable old man.

Pegasus continued up to Olympus, and once again carried thunderbolts for Zeus. For his efforts, Zeus made him into a constellation. A single feather from Pegasus's wings fell to earth and there the city of Tarsus (meaning feather) was founded in what is now Turkey. This city is now a filthy ruinous town called Tersous.

Pegasus is a northern constellation that travels right over our heads during the November nights. The Square is quite obvious, rising in the northeast during November evenings. The gem in this constellation is the globular cluster M-15. This is one of the most densely packed globulars in orbit around our Milky Way galaxy. Hubble Space Telescope photos show that this cluster has undergone "core collapse". This occurs when the stars in the central area of the cluster occupy a small area at the center of the cluster. Core collapse is not unusual in the evolution of older globular clusters. Even though M-15 is relatively nearby, it is still unclear if the core collapse is caused by a supermassive object like a black hole at the center of the cluster, or if the core collapse occurs simply from the mutual gravitational interaction of the stars in the cluster. Continued research should someday clear this up.

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Colors - Part 1

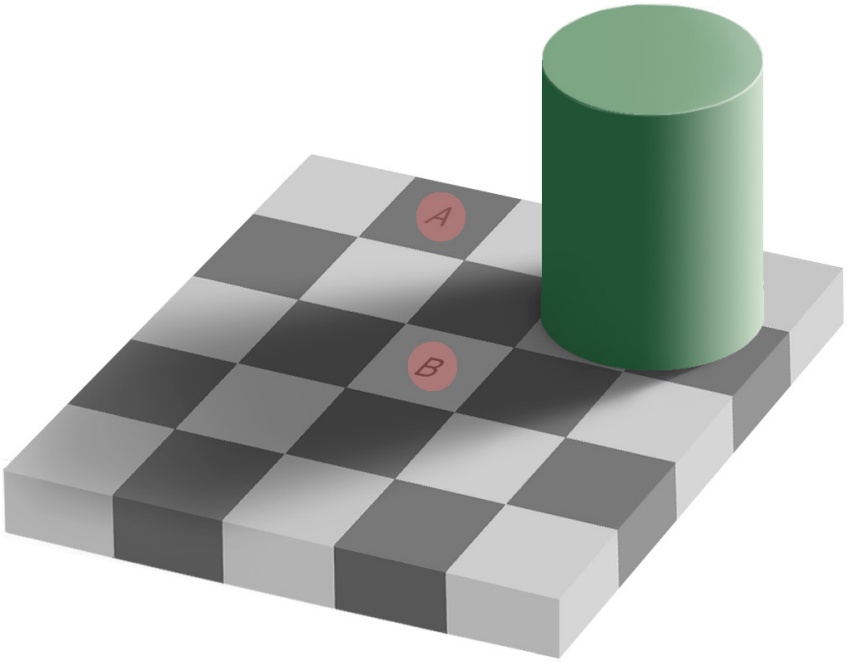
By Alex Woronow

Before I first started researching color, I thought it was a simple topic: Light carries the information about colors in its wavelengths; some of which we humans can see and some of which lies beyond our visual range. That's almost correct, but at such a elementary level that it contains very little in the way of intellectual satisfaction--we (or I) can do better!

Over the next several months a series of short articles on color will cover a range of topics relevant, largely, to astronomy. Astronomy, of course, is a *derivative* science, founded upon Physics, Chemistry, Mathematics and Biology. All these fields converge in the study of color, but this series of articles largely will deal with the physics aspects--with scant mathematics and even less chemistry.

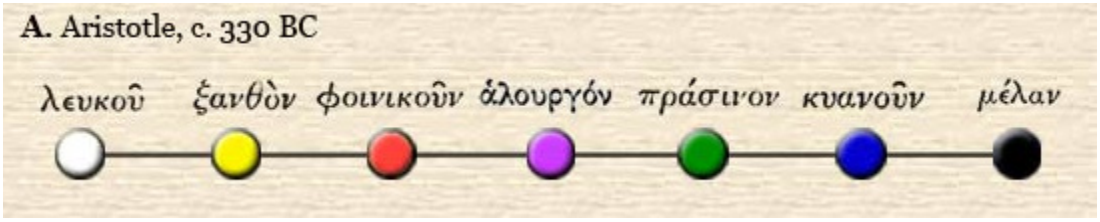
One more thing...being biological critters, I will briefly touch on how our eyes interact with light to perceive colors, hues, tones, luminance, lightness, shades, ..., and what those terms mean. Just as a tease on this topic of physiology, and very relevant to image processing, in the picture below of the *checkered shadow illusion*, the

two squares labeled A and B have exactly the same shade of gray, and the pink circles (they are not eclipses) also share exactly the same shade of pink. Download the picture into an image processing program and use the eyedropper to verify this, if you wish. This illusion exploits our automatic "Color Consistency"--perception adjustments that work to keep colors looking the same in shadow and light, here fooled into failing.

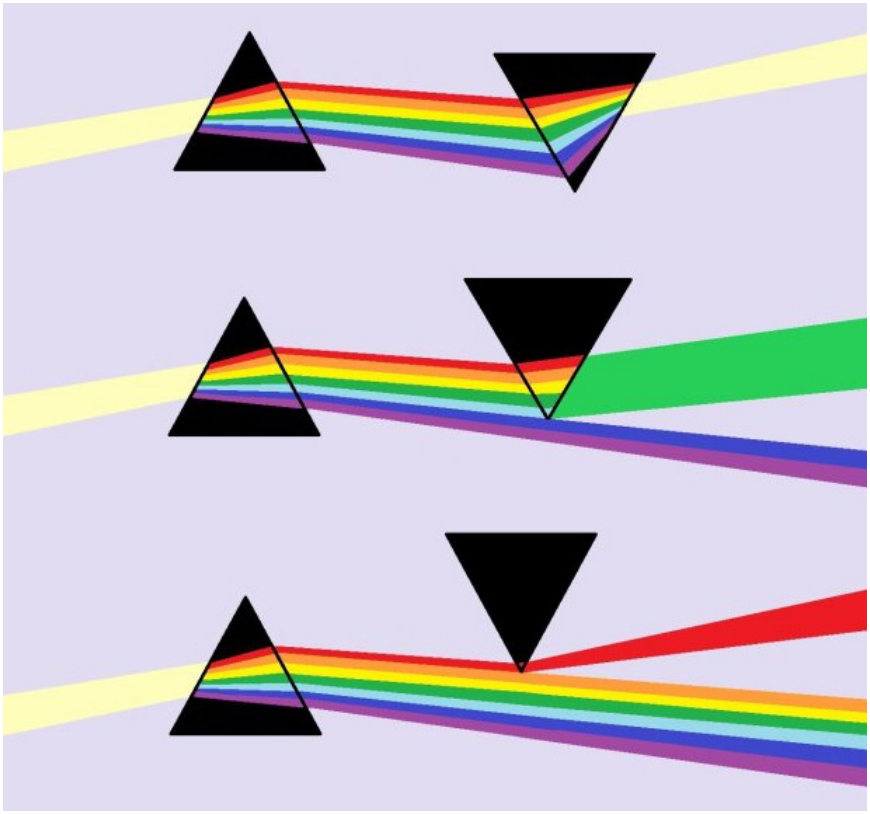


A Brief History

Theories of color, their origins, causes, and perception date back to Early Greece. Aristotle's work, On Colors, (c.300BC) suggested colors were sent from the gods as celestial rays of light and that various colors could be made by mixing black and white. This led to the suggested mixing order shown below:



Aristotle was not the first of the ancients to speculate about color, nor the last. But it was up to Sir Isaac Newton, in his great treatise, *Optics*, to set the path along a new theory of light and color. The well-known breakthrough occurred when Newton passed a beam of white light through a prism and discovered that the light split into the colors of the rainbow: red, orange, yellow, green, blue, indigo, and violet. Being a scientist of the finest quality, Newton did not simply split white light into its component spectrum, but he showed that the spectrum could be reassembled to a white beam, that reassembling a portion of the spectrum yielded a specific color, and that each component color could not be split further. Here is a representation of his experiments (by Helen Klus):



Newton's work was just a beginning. So much more has been discovered about light and color from the physics of electro-magnetic radiation to the physiology of color perception (and gray-scale perception), to the reproduction of "accurate" colors on substrates and devices.

Still, I have not touched upon the actual origin of light and color. In astronomy we encounter physical origins of color such as black-body radiation and emission from excited atoms of hydrogen, oxygen, nitrogen, sulfur, and so forth. But the world of radiation also includes bioluminescence (think jellyfish), Triboluminescence (hit a piece of the mineral quartz with a hammer or rub two pieces together and it generates a flash of light), Electroluminescence (e.g., LED) and others (see here). Most of the latter light generators are, as for now anyway, not of central interest to astronomers, amateur or otherwise. But the former two certainly are!

Origin of Light

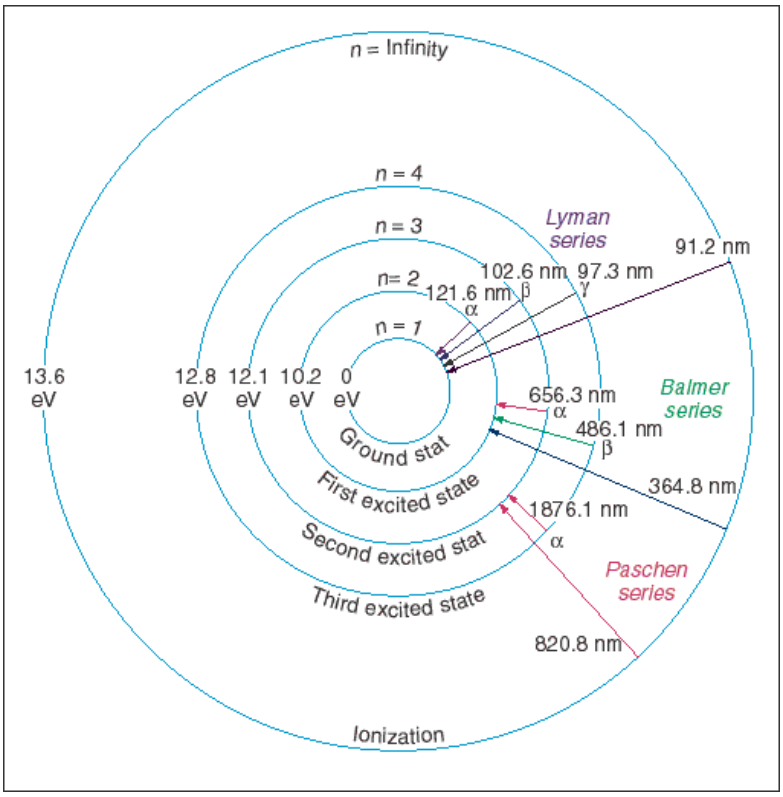
Light arises when a system changes its energy content to a lower value. The "systems" of most interest in astronomy are atoms and molecules. For instance, the electron around a hydrogen atom has a ground state orbital--the lowest energy "orbit" around its nucleus. The electron has a negative charge and the nucleus, proton, has a positive charge. They attract each other. When the electron is in the orbital closest to the nucleus, it is in its "ground state," experiencing the strongest pull from the nucleus. To move the electron to a higher orbital, we must exert energy--which is imparted to the electron. Let to its own devices, that excited electron will eventually decay to, or resume, its ground state. When it does so, it gives back that energy that originally lifted it out of that state. It gives it back in the form of an electromagnetic wave--LIGHT.

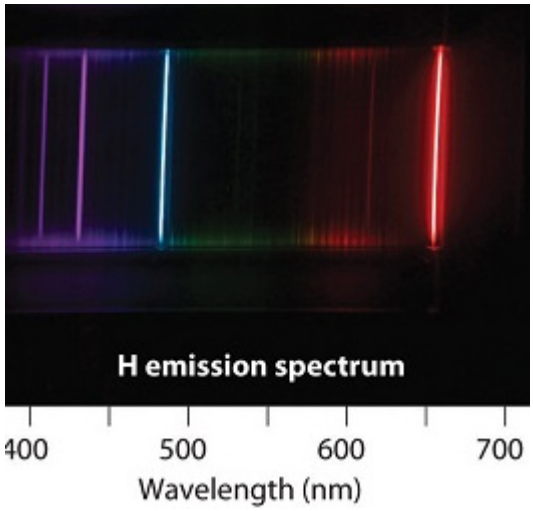
Excitation of the electron to a higher-energy orbital might occur through a collision (say with another hydrogen electron) or by adsorbing a quantum of light. An electron can be excited to a degree that it no longer is bound to its atom and it becomes a *free electron*. When those electrons fall to a lower state of excitement they radiate away the difference in their before and after energies. The color of that radiated light depends on the energy according to the simple equation

Energy = $h\nu$ & Wavelength = c/ν

where h is Plank's Constant, ν (Nu) is the frequency of the emitted light and c is the speed of light. So, as wavelength becomes longer--redder--the energy of the photon decreases.

Let's look briefly at the energies of hydrogen orbitals and where that ever-present Hα emission arises. The diagram of the hydrogen atom's energy states (below) show many of the orbitals (blue) and their energy levels relative to the ground-state orbital. Hα radiation occurs when an electron falls from the second excited state to the first excited state. This transition, downward into the first excited state, is a member of the "Balmer Series." Examples of other series, the "Lyman Series" and "Paschen Series" are also illustrated. In the right portion of the figure, the Hα emission line is at the right--red, as we have come to appreciate.





Narrow-band images collected by amateurs and professionals alike usually utilize Hα, OIII, and SII filters. The Roman numerals after the O (oxygen) and S (sulfur) indicate how many electrons have been completely dissociated from the atoms, leaving behind an ion. Strangely, the convention is that the number of I's is one more than the number of electrons freed which also equals the charge on the ion. Therefore, the OIII ion is missing 2 electrons and has a charge on the remaining ion of -2e.

The atomic structures of elements other than hydrogen are far more complex, with many orbitals and subshells. Subsequently, the available transitions are many! One historic consequence of this complexity arose when OIII was first observed in a planetary nebula in 1927. It was thought to be a new element because the transition that yields this color light from doubly-ionized oxygen is a"forbidden transition" (a quantum-mechanics thing and, obviously, a misnomer). The new element was named *Nebulium*. OOPS!

Next Discussion

Not totally settled until I actually write it, but I expect to discuss some of the elementary aspects of color stars as black-body radiators, from coolish red stars to very hot blue stars. I leave you with this question, if there are red stars and blue stars, why are there no intermediate-color, green stars? Stay tuned.

B 33 / LDN 1630 / Horsehead Nebula

I've finally reverted to the onerous task of image processing. This image has a lot of new approaches for me, including using PixInsights HSVSeparation Script (successfully, for the first time). It repairs those white (or pink) star cores that arise after stretching. Virtually all the large blue stars in this image had one of those types of cores... but no longer! Here are the details

OTA: RCOS (14.5" f/8) Camera: SBIG STX-16803 Observatory: Deep Sky West
EXPOSURES: Red: 10 x 1200 sec Blue: 9 x 1200 Green: 6 x 1200
Hydrogen: 28 x 1200 Total exposure ~18 hours
Image Width: ~1/2 deg Processed by Alex Woronow using PixInsight & others in 2018

The Horsehead Nebula lies near the most eastern star in Orion's belt and at a distance of ~1500 light-years from earth. It is part of the Orion Molecular Cloud Complex, and an active region of star formation. The streaks of red glowing gas (ionized hydrogen) radiating from the dark nebula are guided by magnetic fields. This glowing band of gas marks the edge of the Orion Cloud. The opacity of the Horsehead Nebula itself results from the presence of abundant dust. To the lower left is NGC 2023, an emission/reflection nebula discovered by William Herschel in 1765. Spanning ~4 light-years, it is one of the largest known reflection nebulae. (Source: largely Wikipedia)
Processing Summary: Calibration using PixInsight Script. Aligned/Stacked/MURE, and applied Pre-stretch HSV Separation Script. Masked stretch of repaired Sv then recombined HSV. Separated stars from nebula. Process star saturation and sharpened nebula--recombined Stars+Neb., more adjustments.

NGC 4361, Planetary Nebula in Corvus

Other than galaxies and stars, the constellation of Corvus, the Crow, appears to have only one other object of interest: the 11th magnitude planetary nebula, NGC 4361, discovered by William Herschel in 1785 using an 18.7-inch reflector. This planetary is 2' in diameter with a very hot 13th magnitude Population II progenitor star in the center of the nebula. It is ejecting ionized gas in an expanding shell during the last stage of its life to make the nebula and become a white dwarf in the process.

There are four lobes visible in the image; these are produced by outflows of gas and dust from the central star. The appearance leads some to think it looks like a spiral galaxy. The outflow in NGC 4361 bumps up against the outer blue halo, creating a shock front that provides an additional heating source for the nebula. The rarefied coronal gas near the central star has temperatures on the order of 1,000,000 K.

The unusual appearance is difficult to explain. A bipolar flow of gas has been detected but that would lead to two lobes. Some astronomers, therefore, think perhaps two stars are involved. Date: 2014-06-20

Instrument: 457mm Newt, SBIG ST-8300M, MPCC, OAG, Lodestar Autoguider
Acquisition: Processing: Exposures: Maxim DL Maxim DL, PixInsight, GIMP 12x120s 1x1 L + 7x60s 2x2 RGB Total imaging time: 45 minutes. References: 1. Various 2. Wikipedia 3. The kinematics of NGC 4361, a Population II planetary nebula with a bipolar outflow. MNRAS, 1999 Image and text by Kent DeGroff