The High Desert Observer

March 2019

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, 2019

Board@aslc-nm.org

President: Tracy Stuart; President@aslc-nm.org

Vice President: Ed Montes; VP@aslc-nm.org

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

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March Meeting --

Our next meeting will be on ***Friday, March 22***, at the Good Samaritan Society, Creative Arts Room at 7:00 p.m.

The speaker will be Steve Barkes and the topic will be Amateur Spectroscopy.

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

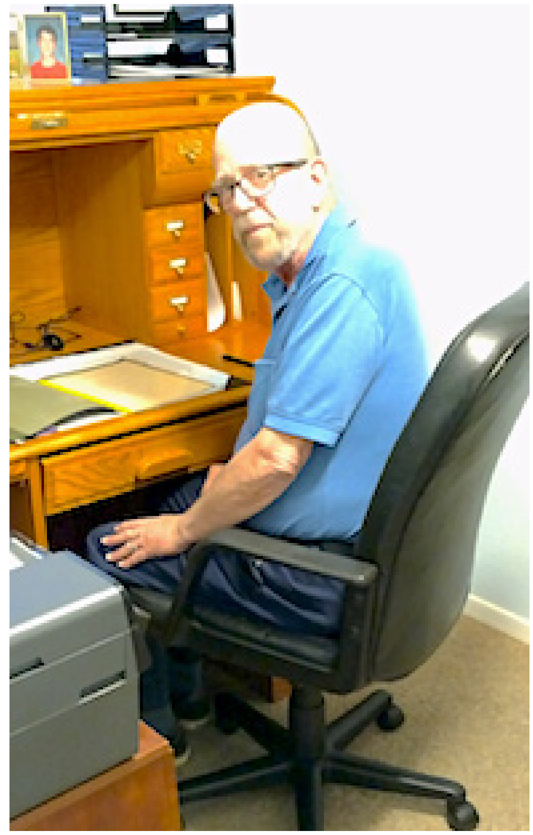
ASLC hosts deep-sky viewing and imaging at our dark sky location in Upham. We also have public in-town observing sessions at both the International Delights Cafe (1245 El Paseo) and at Tombaugh Observatory (on the NMSU Campus). All sessions begin at dusk.

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.

From the President's Desk

***March* 2019**



There is a most interesting 14-year partnership between NASA and the Navajo Nation that helps teachers present cultural and scientific information on an equal footing. It seems that the dine' traditional ways of knowing are inherently scientific. According to Daniella Scalice the education and communications lead at the NASA astrobiology Program. "There is no difference between traditional cultural ways of generating knowledge and the ones science uses." Angela Barney Nez, a partnership co-founder and executive director of the Dine' Bi Olta School board Association said, "Prescriptions to life are written in the stars."

With this in mind the topics covered first speak to the Navajo tradition then incorporate the Western science's way of seeing the world. For example one of the activities is built on Navajo associations with each of the four cardinal directions, the seasons, and four Spiritual Ones. The scientific view of a star's life follows the same four-step cycle as is described in the Dine' beliefs: from a nebula to a new born star to a mature star to a nova.

Dana Desiderio a grad student at Navajo Technical University studying Dine' culture said, "Navajos are natural scientists in so many different ways, and we see it spelled out in their culture. We see how indigenous knowledge is already present in many scientific discoveries that we know today."

I am sure that you can see that as a teacher I would find this most interesting.

Our speaker this month we be our friend and colleague, Steve Barkes who will be speaking on Amateur Spectroscopy 1st Steps with the Alpy600. He will talk about spectrograph design highlighting the ALPY from Shelyak Instruments, spectrographic targets for amateurs, and software and processing/ reduction of spectrographic data.

Tracy Stuart, ASLC President March 2019

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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

2019 February Report

Rockhound State Park, Saturday February 2nd

Unfortunately this event was cancelled because of clouds and high winds. Mike Nuss was ready to present. The Ranger agreed with the decision but were nevertheless disappointed.

Leasburg Dam State Park, Saturday, February, 23

Chuck Sterling, Bob Armstrong, Jerry McMahan, and Steve Woods supported the event attended by a group of Boy Scouts from El Paso with their parents, most of whom stayed at the park camping overnight.

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

Mar	01	18:05	Sun Sets
	01	22:44	Mars Sets
	01	01:54	Jupiter Rises
	02	18:00	OUTREACH; NPO Program at City of Rocks SP, B. Nigg, C. Turner
	02	18:00	OUTREACH; NPO Program at Rockhound SP, M. Nuss,
	06	09:04	New Moon
	07	18:30	OUTREACH; Sunrise Elementary Star Party: 6:00 to 7:30 PM
	10	02;00	Daylight Saving Begins: Spring Forward
	14	04:27	First Quarter Moon
	15	20:00	OUTREACH;Tombaugh Observatory Open House: 8:00 to 9:00 PM
	16	19:30	OUTREACH; MoonGaze, International Delights Café
	16	19:30	OUTREACH; MoonGaze, Pan Am Plaza on University Ave
	18	03:05	Jupiter: Double shadow transit, Ganymede & Europa; Alt 09° 24'
	20	19:44	Full Moon
	22	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room
	25	06:56	Jupiter: Double shadow transit, Ganymede & Europa; Alt 34° 57': At dawn
	27	22:10	Last Quarter Moon
	30	19:30	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	30	19:30	OUTREACH; NPO Program at City of Rocks SP, B. Nigg, M. Nuss, C. Turner
Apr	01	19:27	Sun Sets
	01	23;22	Mars Sets
	01	01:03	Jupiter Rises
	05	02:51	New Moon
	06	19:30	OUTREACH; NPO Program at Rockhound SP, M. Nuss, B. Nigg, C. Turner
	12	13:06	First Quarter Moon
	12	19:35	OUTREACH; Spacefest 2019 Stargazing at La Cueva Picnic Site, Dripping Springs
	12	21:00	OUTREACH;Tombaugh Observatory Open House: 9:00 AM to 10:00 PM
	19	05:12	Full Moon
	23	10:00	OUTREACH, Bright Beginnings Solar Star Party: 10:00 AM to 12:00PM
	26	16:19	Last Quarter Moon
	26	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room
	27	19:45	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	27	19:42	OUTREACH; NPO Program at City of Rocks SP, B. Nigg, C. Turner
	28	09:00	Texas Star Party Begins: April 28 to May 5, 2019

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

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Announcements

1. The March ASLC meeting will be held on March 22, 2019 at 7:00 PM at the Creative Arts Room, Good Samaritan Society Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, New Mexico. The program for the March meeting will be a presentation by Steve Barkes, as ASLC Director at Large. His topic will be Amateur Spectroscopy. Maybe he will tell us about the recent Spectroscopy Workshop.

2 FROM LAST MONTH: There is another rare astronomical event coming to Las Cruces in February. On Feb 18, 2019 at about 10:21 pm, asteroid (4388) Jurgenstock will occult the bright star Sirius for almost 2 seconds. It is not too soon to begin planning for this event.

If you would like to know more about occultations and this evert, here are two valuable links:
http://occultations.org/observing/
http://www.asteroidoccultation.com/2019_02/0219_4388_62950.htm

Attention: This event was **Cancelled! What?** How can anyone cancel a cosmic event? It is easy; just check your calculations! In checking the calculations, someone discovered that the previous path of Sirius and the asteroid was based on the assumption that Sirius was a single star. But Sirius is a double star and although its companion is a small and dim white dwarf, it is relatively massive, - enough to effect the center of mass of the Sirius system. When the new calculations were done, it was discovered that the path of the occultation did not pass anywhere near Las Cruces. It fact it goes about 2000 miles east of here, in the Atlantic and Carribean. Quick, cancel the flight to El Paso! Get me a flight to Bermuda or the Bahamas, or someplace warm. After all, it is February.

3. 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
February 2019

Show and Tell:

Chris Brownewell started tonight's Show & Tell session with a report on the 2019 Winter Star Party in the Florida Keys. He was the Stellar Vision, Tucson, AZ, representative and demonstrated their roll-off roof observatory design and equipment. He also won an award for his astro-photography.

Ed Montes announced that the play "Silent Sky", about astronomer Henrietta Leavitt, will be presented at New Mexico State University (NMSU) this weekend and next, Feb 23 and Mar 2.

Call to Order:

Tracy Stuart, President, Astronomical Society of Las Cruces (ASLC, the Society), called the February 2019 business meeting to order at 7:10 pm, 22 February 2019, Conference Room, Good Samaritan Society Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, New Mexico.

President's Comments:

Tracy Stuart, President, welcomed the group to the February meeting. He noted that the Society was meeting in a different room tonight to accommodate the needs of the Good Samaritan Society. He welcomed Brad Thomas and Terzah Horton of the George Observatory, part of the Houston Museum of Natural Science, Houston, TX. They are exploring possible locations for retirement. Former Society President Vince Dovydiatis and his grandson Stuart Hutchins were attending tonight's meeting. Paul Mason was also visiting.

Tracy reported that the January 2019 meeting minutes were published in the February issue of the High Desert Observer (HDO), the Society's newsletter. He asked that the January meeting minutes be accepted; Ed Montes moved that they be accepted, Gary Starkweather seconded. The minutes were accepted.

Treasurer’s Report:

Trish Conley, Treasurer, provided a summary of the Society’s finances. She had received $687, primarily for 2019 membership dues, apparel, and some contributions, since the last meeting.

Outreach:

Chuck Sterling, Program Coordinator, announced upcoming events. There will be a 3rd Quarter Moon event at Leasburg Dam State Park (LDSP) tomorrow night, 23 February. Although the weather is not predicted to be favorable, a group of Boy Scouts will be camping at the Park and would like an opportunity to observe through the telescope. There will be a star party at Sunrise Elementary on 07 March. A Moon Gaze will be held 16 March at two locations: International Delights Café and El Milagro Coffee y Espresso in the Pan Am Plaza. Another 3rd Quarter Moon event at LDSP will be on 30 March. An open house will take place at Tombaugh Observatory on 15 March on the NMSU campus.

Old Business:

Tracy reported that he continues to coordinate with KRWG (the local PBS affiliate) on a “Community Connection” segment featuring ASLC. The “Community Connection” is a locally produced video segment that features local nonprofits and government programs that are making a difference in the region. Details will follow.

Presentation:

This month’s presentation was by Dr. Stella Kafka, Executive Director of the American Association of Variable Star Observers (AAVSO) on “Variable Stars and their Stories – The Good, The Bad, and The Explosive”. Dr. Kafka noted that while AAVSO was started at Harvard University in 1911, today it is an international organization.

A primary activity of AAVSO is building light curves of spatial objects using multiple methods from naked eye observing to using very large instruments. AAVSO has many resources to assist amateur astronomers get started making observations, including how to submit their observational data.

The AAVSO will be holding its 108th Annual Meeting, “Science Under the Same Dark Skies”, at the Hotel Encanto, Las Cruces, NM, 17-20 October 2019. Member Tim Kostelecky volunteered to act as the point-of-contact between the AAVSO and ASLC for this event.
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The February meeting of the Astronomical Society of Las Cruces concluded at 8:33 pm. A social time followed at Pecan Grill.

-Respectfully submitted by John McCullough, ASLC Secretary

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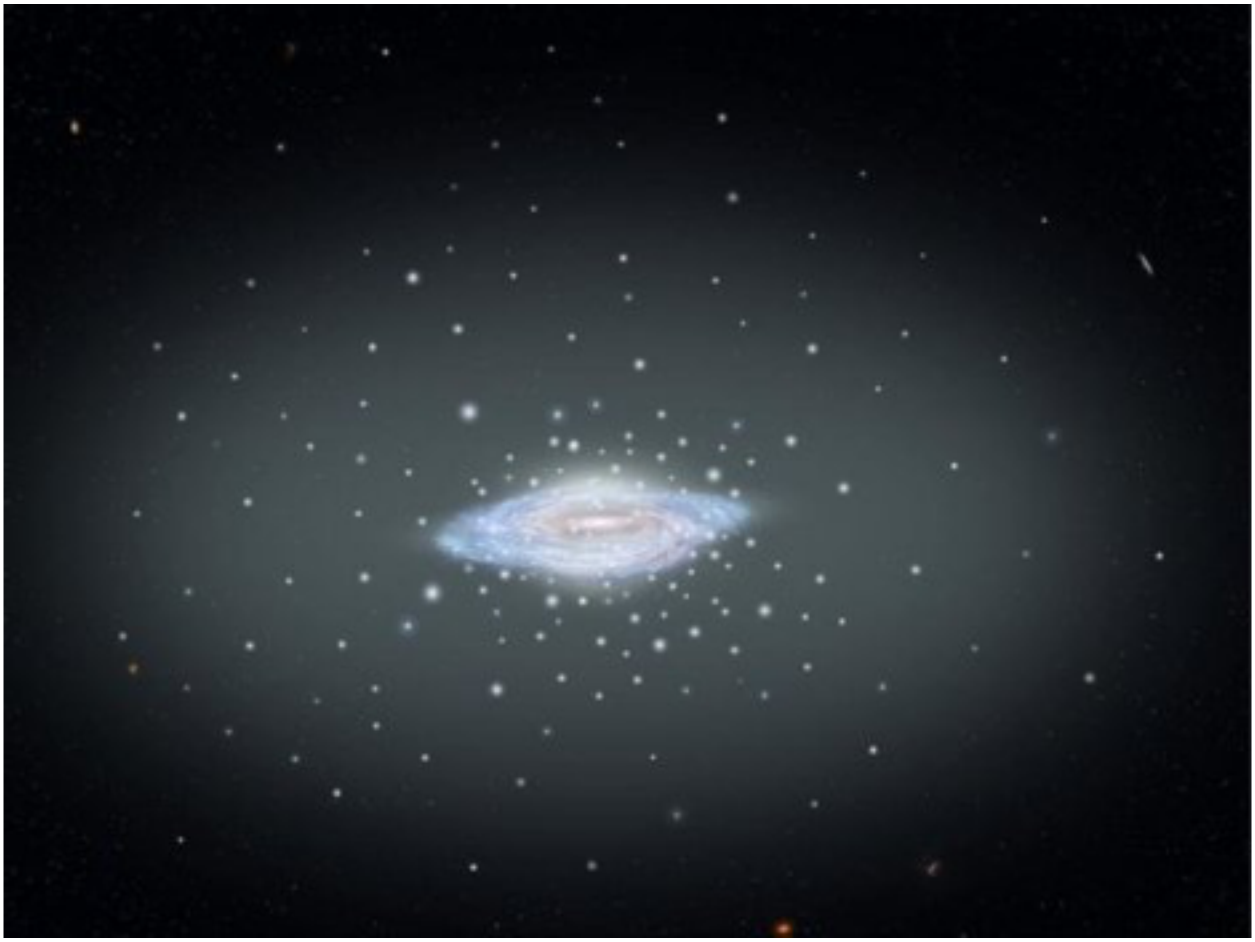
Hubble Space Telescope has new camera glitch

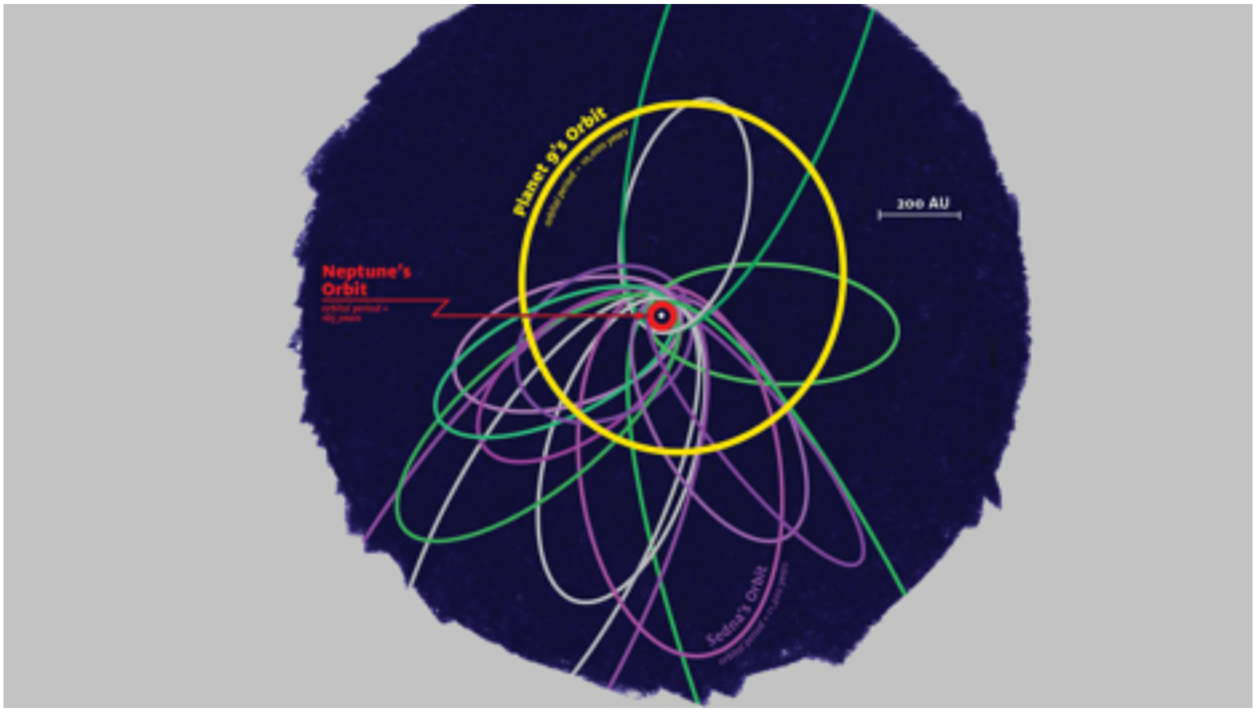
Hubble's Advanced Camera for Surveys instrument suffered a glitch on Feb. 28 and has gone dark. An error indicating that software inside the camera had not loaded correctly popped up during what was supposed to be a routine computer procedure. The Advanced Camera for Surveys is a visible llight instrument that has taken some of Hubble's most spectacular images of the universe. A team of Hubble engineers, software experts, and flight controllers is working to identify the root cause and come up with a recovery plan.

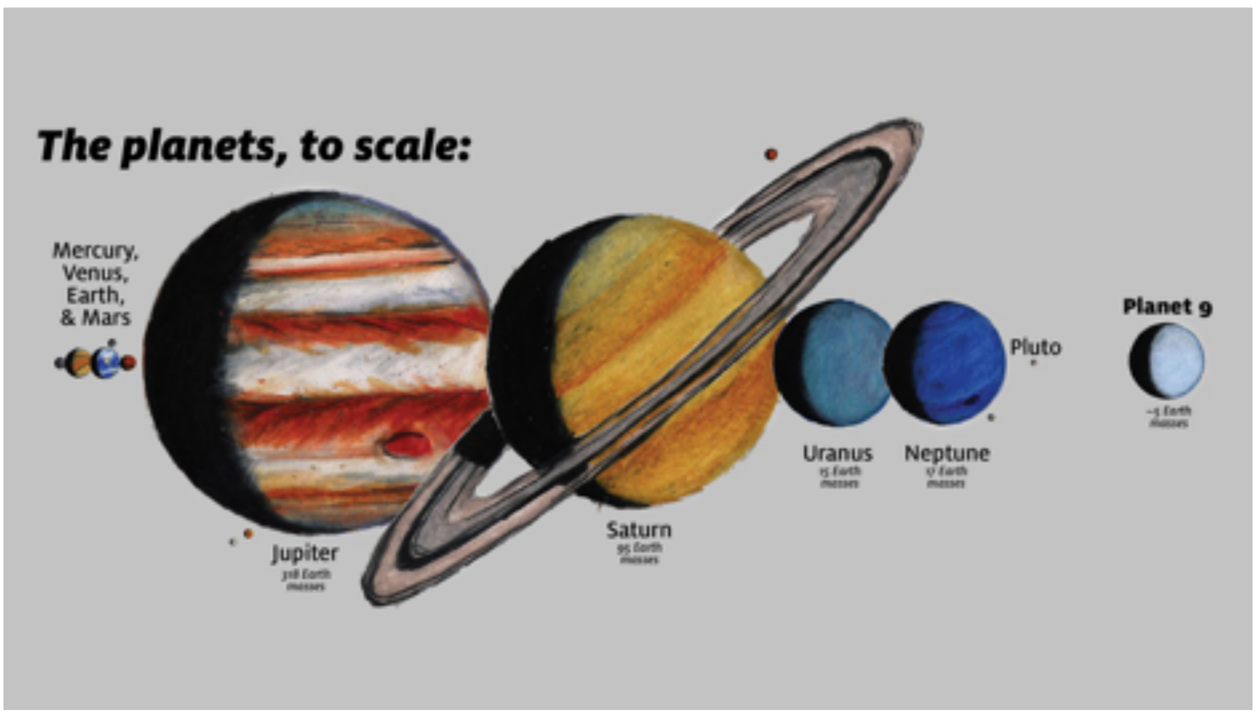


What is the Milky Way's mass?

Astronomers have come up with one of the most accurate measurements to date of our galaxy's mass using the Hubble Space Telescope and the European Space Agency's Gaia satellite. They have determined that the Milky Way weighs in at about 1.5 trillion solar masses, including a 4 million solar mass black hole at the center. The black hole plus the approximately 200 billion stars comprise only a small percentage of the total mass. The rest of the mass is comprised of the invisible substance currently referred to as dark matter. In order to determine this new mass estimate astronomers used Hubble and Gaia to measure the three-dimensional movement of globular star clusters.

Support for Planet Nine





Mike Brown and Konstantin Batygin of the California Institute of Technology are publishing two papers analyzing the evidence for the existence of a Planet Nine. Based on new computer models of the dynamical evolution of the distant solar system, they and two astronomers at the University of Michigan have concluded that Planet Nine has a mass of about five times that of earth and an orbital semimajor axis of about 400 astronomical units. This makes it smaller and closer to the sun than previously hypothesized and potentially brighter. Brown and Batygin say that the more they examine the orbital dynamics of the solar system the stronger the evidence that Planet Nine actually exists.

Sky & Telescope For Sale, Maybe

On March 11, 2019, **F + W Media**, the parent company of Sky & Telescope filed for bankruptcy protection under Chapter 11. Faced with liquidity problems, only about 2.5 million in cash and over 100 million in outstanding debt, the company felt that it had no alternative. **F + W Media**,is one of the largest publishers of specialty and enthusiast media in the country. Its portfolio is diverse and includes onlne education, print books and magazines, digital books and magazines, subscription video sites, consumer and trade events, and curated e-commerce stores. Its brands include *Deer* and *Deer Hunting*, *Sky & Telescope, Old Cars Weekly*, *Popular Woodworking*, *Coins*, *Numismatic News*, and various crafting titles, among others. The New York company plans to sell its businesses while continuing to operate in order to maximize their value.

The following is an email from the Editor of S & T to Contributing Editors:

"Dear Contributing Editors,

You might have heard rumors already, but in case not, I wanted you to hear it from me first: S&T's parent company, F+W Media, filed for Chapter 11 yesterday. Over the coming months, while under bankruptcy protection, F+W will strive to sell the company's assets, including Sky & Telescope..

The S&T staff (whom I'm bcc'ing on this email) only learned of this today, so I would ask your patience as we learn more about what this means for us, for all we produce, and for you, our loyal contributors.

As I understand it at this early stage, it's essentially business-as-usual during this "restructuring" process, and we on staff will continue to do everything we've always done.

I don't have much more information than that at the moment, but feel free to email me or even call me at the number below if you have questions, and I will try in time to get them answered.

Also, please spread the word that we at Sky & Telescope are actively seeking a qualified buyer. Please have all ideas for potential new owners sent directly to me.

Thanks again for all the solid work you do for us. I feel strongly that S&T will come through this intact, maybe stronger than ever.

Best regards,
Peter
--
Peter Tyson
Editor in Chief
Sky & Telescope"

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The Uranograph - March 2019.
By Bert Stevens

Constellation of the Month: Canis Major, The Big Dog.

This month, we are looking to southeast of Orion toward one of his hunting dogs, the big one, Canis Major. Greek mythology has Canis Major about to leap on his neighboring constellation Lepus, the Hare. This makes a celestial tableau with Orion, Canis Major, Canis Minor and Lepus forming a hunt across the winter sky. However, in Native American mythology, Canis Major represented a deer hunter, with Orion representing a stag with the three stars of Orion's belt being an arrow lodged in its side.

The gem of this constellation is the brightest star in the sky, Sirius, more commonly known as the "Dog Star". In ancient Egypt, people noticed that Sirius would appear in the early morning sky shortly before sunrise in mid-July. Within a week or two, the August floods would come down the Nile and deposit a fresh layer of fertile silt so the next year's crop could be planted. Since these were the hottest days of the year, they were referred to as the "Dog Days" of summer. The walls of Egyptian monuments and temples dating back as far as 3,000 B.C. have Sirius' hieroglyph, the dog, clearly depicted.

Sirius is associated with the goddess Isis, sister and wife of Osiris, the Sun god. Isis is the most important of the Egyptian goddesses and is associated with motherhood, healing the sick, and magical spells and charms. The chief god Ra told her his secret name, making her the most powerful magician in the universe.

Isis is responsible for helping her husband return to life. She then assisted him in ruling the Land of the Dead. The appearance of Sirius in the morning sky is a representation of Osiris's return from the dead.

Sirius is a white giant star (spectral class A0) that is only 50 trillion miles (8.6 light years) away. This allows it to shine at magnitude –1.46, making it one of the brightest objects in the night sky with only the Moon, Venus, Jupiter and Mars being brighter.

In the 1830s and 1840s, astronomer Frederick Bessel analyzed the motion of Sirius against the farther-away stars and determined that it was not moving in a straight line, but wiggling back and forth as the gravity of an invisible companion was tugging on it. The orbit of the companion was computed, but the search for it proved fruitless.

Being such a bright star, telescope makers have used it for testing new telescopes. In 1862, famed telescope maker Alvan Clark was testing a new lens, an 18½-inch that was the largest in the world at that time. It would eventually be installed at the Dearborn Observatory of Northwestern University in Evanston, Illinois, which at the time had a dark sky on the shore of Lake Michigan. The Chicago metroplex has now swallowed up Evanston and the Northwestern Campus, so this one-time world-class instrument is now used mainly for viewing the planets by the public.

While Alvan Clark was looking at Sirius with this excellent telescope, he saw the companion star. It surprised astronomers in being 10,000 times fainter than Sirius. Dubbed Sirius B, this newly-discovered star was not shining bright enough to be a normal star, which is why it had not been seen earlier. Measurements eventually showed that Sirius B (sometimes called "The Pup") is the same temperature as the Sun, about the same mass as the Sun, but the entire star is contained in only 90% of the diameter of the Earth. Objects on the surface of Sirius B weigh 400,000 times what they do on the surface of the Earth.

Matter here on Earth is nowhere near dense enough to get this much mass into such a small space. Astronomers could not understand how such an object could exist. In the 1920's, R.H. Fowler of Cambridge University, using the newly developed theory of quantum mechanics suggested that white dwarf stars like Sirius B were made of normal matter that was so tightly packed that only the electrons that make up the outer part of atoms were pushed as close to the nucleus as they could go. Technically, the electrons were all pushed to their lowest energy state allowed by the Pauli Exclusion Principle. They then pushed back, this effect being called degenerate electron pressure. It was now clear that after using up its nuclear fuel, the remnants of a star like the Sun contracts into a white dwarf.

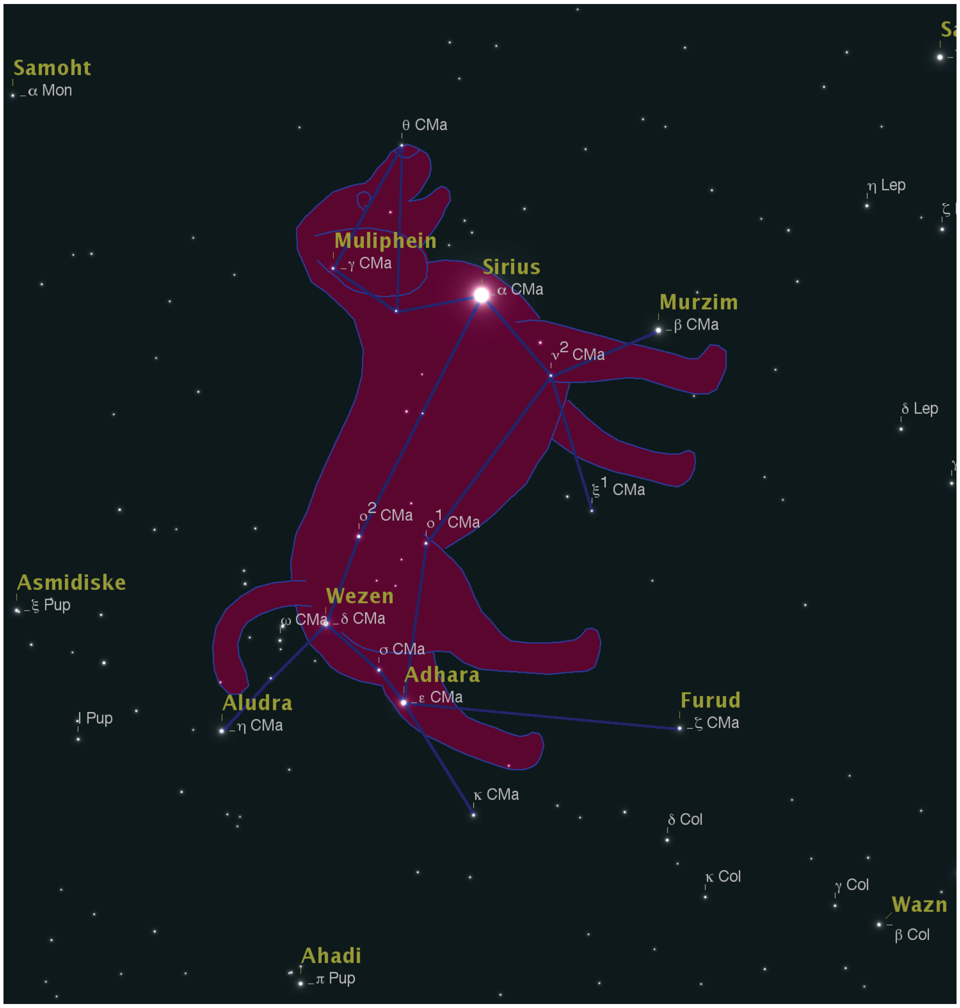

Figure 1:
Constellation of Canis Major and Sirius, the brightest star.

This gave a general answer to the riddle of the white dwarf. The details were worked out in the 1930s by Indian-American astronomer Subrahmanyan Chandrasekhar. By combining quantum mechanics and the theory of relativity he showed that the electrons could keep a white dwarf from collapsing further, if the mass of the white dwarf was less than 1.4 times that of our Sun, called the Chandrasekhar limit. If mass was added, say in the form of gas from a nearby star (even closer than The Pup is to Sirius), then eventually the mass would exceed the Chandrasekhar limit and gravity would force the electrons into the protons of the nucleus turning the two particles into a single neutron. The entire white dwarf then collapses in a Type I supernova explosion. The end result would be a neutron star, some ten miles wide, but still with a mass greater than that of the Sun.

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Color: Part 3
The Colors of Galactic Clouds
By Alex Woronow

Introduction:

Interstellar nebulae command the attention of both visual observers and astro-imagers. For the visual observer, these nebulae seldom display much, if any, color. But, for the imagers, a full array of colors appears. In this article I describe what physical processes in the nebulae give rise to these colors. Bear in mind that imagers are an unpredictable lot, and the red light of Hα, for example, may be rendered blue or green or any other color. Ground-rules do not apply to assigning narrow-band-image colors, for sure, and are not even required for broad-band imaging.

Limitations of Observing Colors in Nebulae:

Unfortunately, human perception of color has impactful limitations. In dimly lit scenes, our eyes' color receptors (cones) shut down and pass the task of seeing on to our gray-level receptors, the rods. The rods have higher spatial resolution and greater sensitivity to low light, but without the cones, input, the color of nebulae eludes us. Then too, our eyes can sense only a limited range of wavelengths. Some "colors" lie in the ultraviolet or infrared, for instance, and do not stimulate a visual response, but may be captured in images, particularly by professional equipment. Additionally, many nebulae have little or no color in the visual spectrum, and they may appear black against starry surroundings. Fortunately, many nebulae do have a variety of hues: reds, blues, greens, and such, and a full range of tones, as our cameras can reveal.

Broad- and Narrow-band Images:

The two common modes of imaging are broad-band and narrow-band. For gray-level cameras, the former uses the three primary-color filters, red, blue, green, to span the range of human color perception. Narrow-band imaging uses filters that reject all wavelengths of light except for very narrow windows centered on atomic emission lines. Common narrow-band filters used by amateurs are the Hydrogen α (or H II), the Sulfur II, and the Oxygen III filters. (The notation, such as "III", indicates the ionization state of the atoms. One 'I' indicates a neutral atom; "II" indicates loss of one electron, etc.)

Sources of Nebular Color:

<u>*Dark Nebulae*</u>

First of all, the obvious: colors require the presence of light: no light, no color! If a particular nebula lacks nearby bright stars and is not strongly interacting with other clouds, it neither has starlight to reflect nor energy enough to emit its own light. The results equal a "dark nebula." Some dark nebulae are virtually black. Their dust and molecules absorb what light falls upon them in the visual spectrum and radiate it in the infrared, beyond the reach of amateur imagers. These nebulae have temperatures in the range of 7 to 15° K. In the parlances of professional astronomers, clouds <10° K are "cold" clouds and the others are "warm" clouds--really!. The cold clouds have neutral hydrogen molecules (H_2), and carbon atoms. In the coldest central region they may have CO_2 molecules and exotic molecules such as molecules HNC (hydroisocyanic acid) and its isomer HCN (hydrocyanic acid).

Dark nebulae "dust" consists of various molecules and ices stuck together to form irregular grains in the size range from a few tens of nanometers to millimeters. The dust compositions include graphite, various ices, a variety of silicates, and some carbon-based compounds. The dust grains and cold molecules are light absorbers, and, consequently, their host cloud appears black. When some moderately strong light exists near the dark nebula, the light can bounce off the dust grains, producing a brown tone.

But even dark nebulae are clumpy and some of those clumps attain enough internal gravity to condense into stars. When a new star ignites, it may ionize atoms in the local region, and spawn a "bright nebula." For example, the dark nebula LDN 673 has two visible young stellar objects (YSOs) that have ionized the local gasses (Fig 1).

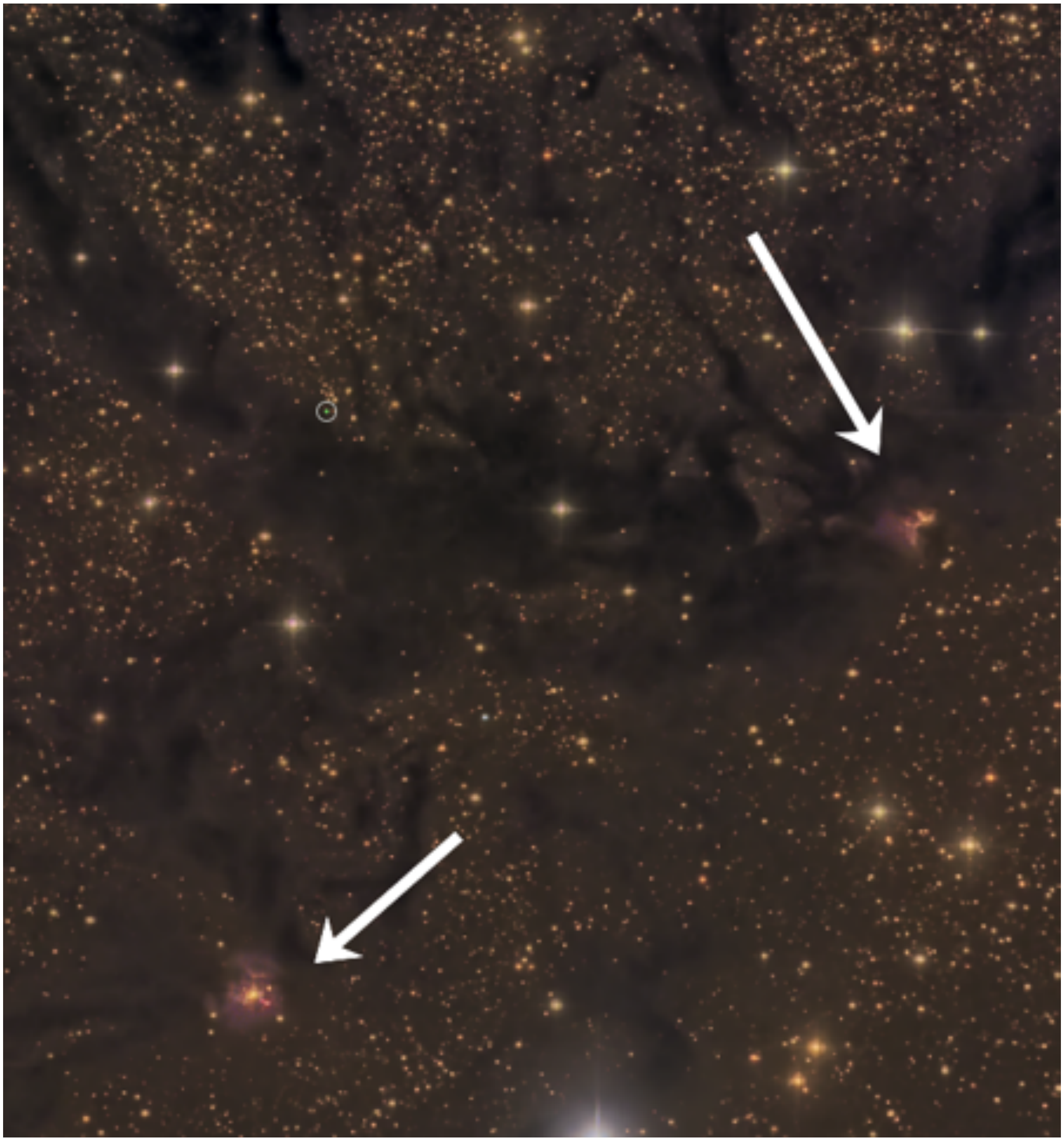

Figure 1. The dark nebula LDN 673 with two obvious sites where young stars ionized the local nebula and spawned emission nebulae. (Image by author.)

But this article is about color; so let's move on to some nebulae that have more of it.

Bright Nebulae: sources of light
Bright nebulae come in two over-lapping varieties. The first is a reflection nebula where the light source is reflected starlight, and the second is a self-radiating nebula where the ionized gasses in the nebula emit the light.

Reflection Nebulae: Reflection nebulae commonly have a blue cast because...

Whether a bright star lies just beyond a nebula and shines through it, or lies just in front of a nebula and shines on it, when the starlight intersects the cloud, it has three options. It can pass through the nebula uninterrupted, be absorbed by the dust and molecules in the nebula, or be scattered (usually multiple times) off the dust and molecules. Of these three possibilities, let's focus on the third, scattering.

Figure 2. NGC 1333 in broad-band RGB. The blue nebular region (LBN 741) largely arises from scattering of light from the YSO BD +30 549, which is in the bright (white) spot at the center of the nebula. (Image by author.)

Scattering affects blue, short wavelengths more than longer red wavelengths. Our daytime sky appears blue because, as the sun shines through the atmosphere, the gas, molecules, and dust, scatter blue photons but do not do too much to the red photons. This wavelength-dependent scattering is called "Rayleigh scattering." Lord Rayleigh (c. 1871) showed that blue light is about 10x more prone to scattering by small particles than is red light. In the earth's atmosphere, molecules of oxygen and nitrogen do most of the scattering because their sizes roughly match the wavelength of the blue light.

(Aside, if shorter wavelengths are more prone to scattering, why isn't the sky violet? The answer lies in human visual perception. Our eyes are not very sensitive to violet, but considerably more receptive to blue light. So if both colors are scattered--and they are--it is the blue that dominates our visual impressions.)

In broad-band images, reflection nebula have an obvious blue component. NGC 1333 (Fig 2) is an example. The YSO BD +30 549, the bright star in the white spot at the nebula's center, provides the scattered light. This nebula has a plethora of young stars that eventually will cause large portions of the nebula to ionize and radiate as a H II-region emission nebula. For now, they are mostly concealed in and behind the dark gases and dust. But eventually, their strong UV radiation will clear a bubble through the cloud and they, and their surrounding ionized cloud, will become visible as emission nebulae.

Emission Nebulae (aka, H II regions): The archetypical H II emission region may be the Orion Nebula. It reveals an abundance of detail in both broad-band and narrow-band images. Among the many other emission nebulae, we find Melotte 15, pictured in Figure 3.

The three most common emission lines explored by amateur imagers are those of excited hydrogen (Hα or, equivalently, H II), doubly ionized oxygen (O III), and singly ionized sulfur (S II). Usually the strongest of these, for emission nebulae, is Hα--by far.

The Hα line is a member of the Balmer Series (Fig 4), with a wavelength of 656 nm, which places the line in the deep red (Fig 5). When the single electron of a hydrogen atom is excited out of its ground state (by absorbing radiation or suffering an energetic collision) it moves to a higher, unstable energy state, or suffers total ejection from the atom. Some time later, the electron spontaneously drops to a lower, more stable orbital and in so doing emits radiation in the form of a photon of light. It may move downward in a number of small steps, or in a single large step. At some point, some of the excited electrons find themselves in energy state n=3 (Fig 4), and sometimes they emit a photo of just the right energy to drop to n=2 energy level (where n is the "principal quantum number"). The photon emitted from that transition is the Hα emission that we capture as red light. For the record, photon energy = hc/λ, where h is Plank's constant, c is the speed of light and λ is the wavelength of the photon. So, as wavelength increases, photon energy decreases.

Emissions from S II and O III follow basically the same phenomena as Hα: the jump of an electron to a lower energy state with the difference in energies (before and after moving) balanced by the emission of a photon at a specific wavelength or energy.

S II emissions also occur in the red part of the spectrum at a wavelength of 672nm--not far from Hα. O III emits in the blue-green, at 500nm. Both O III and S II emissions arise from "forbidden transitions." "Forbidden" is an exaggeration. When an electron is excited into a "meta-stable" orbital, an orbital that is almost stable, and left undisturbed, it will remain there for a very long time before spontaneously decaying to a lower energy state."Long time?" Well, meta-stable states decay in milliseconds to seconds whereas normal excited states decay in the microsecond or less time range. In earthbound laboratory experiments, forbidden transitions are not observed because well before the average decay time is

Figure 3: Melotte 15 is a cluster of young stars, some of which are hidden behind the cloud and some others that appear to the upper right of the bright H II cloud. They are YSOs and their strong UV radiation has ionized the cloud and caused the glow seen here. This is a narrow-band HSO image. (Image by the author.)

reached the excited atom will collide with another atom and energy from the collision will spawn the transition without a photon being emitted. However, in the very rarefied-gas environments of interstellar clouds, with densities of a few atoms/cc, atom-atom collisions occur less commonly and meta-stable electrons do decay spontaneously by emitting a photon.

But how do the electrons get excited in the first place? Why aren't all the electrons in their lowest energy states? Conversely, why are all hydrogen atoms in GMCs ionized? (GMC=Giant Molecular Clouds--common jargon in scientific papers, just like "YSO".)To ionize H, we need a source of energy equivalent to that of a substance at 10,000° K. Few star types reach such high temperatures, but very young and massive O and B stars do. Not coincidentally, "OB associations" are found in H II clouds. O and B stars form from the collapse of the gasses and dust in the GMCs . The OB stars' energetic UV radiation ionizes the gasses moving electrons out of their lowest energy states and usually ionizing the atoms. (It also disintegrates the dust particles.) Furthermore, the ignition of these YSOs sends out hypervelocity

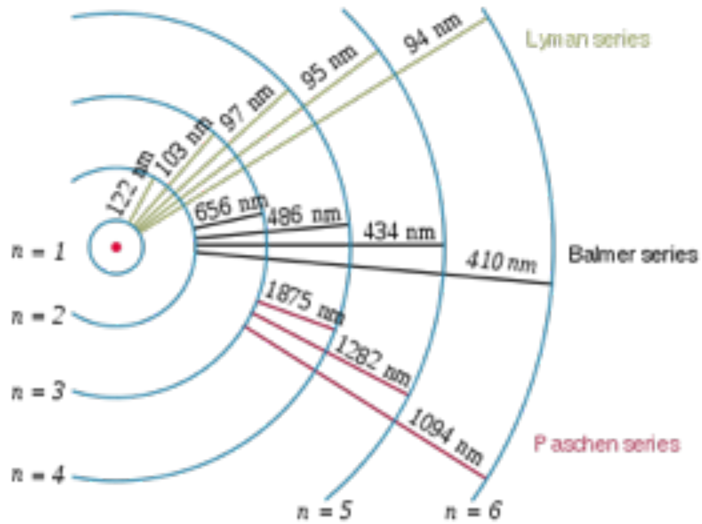

Figure 4. The wavelengths of radiation that an electron in a hydrogen atom emits as it falls from a higher energy (larger n) state into a lower one.

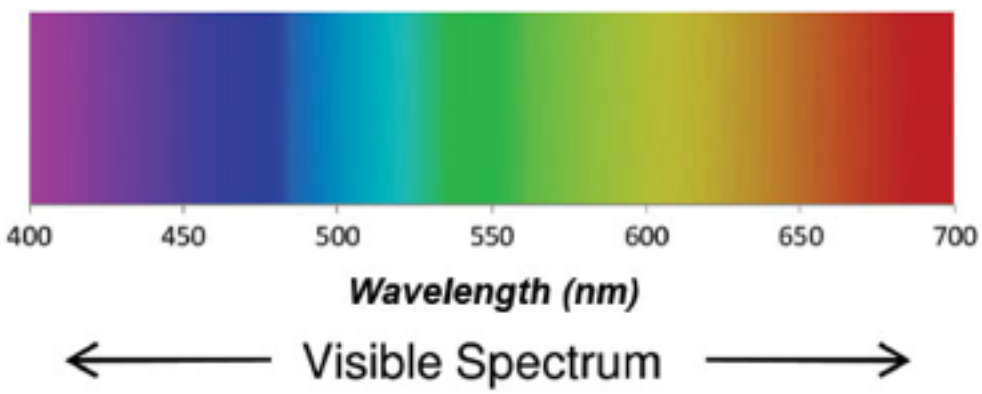

Figure 5. The range of human color perception. Note that only the Balmer series (Fig 4) has photon emissions that fall in the range of colors we can see. Hα wavelength equals 656 nm.

shock waves, dense streams of material, called Herbig-Haro Objects, that impact the surrounding interstellar medium with high energies and also cause it to ionize.

Planetary Nebulae are a little different from the GMC H II regions described above. Their ionizing energy source is not the birth of a star, but a star's demise. The material in a planetary nebula consists of the outer shell of a dying, approximately sun-size, star. The dying star collapses to form a white dwarf with a temperature exceeding 100,000° K--providing far more than enough energy to ionize the surrounding, ejected gasses.

Coming Up

What next? I think it is time to talk about human color perception directly. Color is little more than an artifact of our visual processing. It does not occur in nature; we interpret it. From my first article, you may recall that the night sky has an abundance of green stars, but that's not what we see. The explanation for that, and more, is coming soon. Cheers, Alex Woronow (alex@awkml.com)

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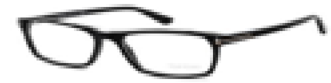
Missing & Found, like my reading glasses

By Gary Starkweather



Well accepted theory is that the Universe is made of Dark Matter, Dark Energy, and ordinary or “Baryonic Matter”, including specific ratios of each, although observation of dark matter remains elusive. As per the λCDM (Lambda cold dark matter) or Lambda-CDM model the total mass–energy of the universe contains 5% ordinary matter (baryonic matter) and energy, 27% dark matter and 68% of an unknown form of energy known as dark energy (wiki).

But even baryonic matter seems to be playing tricks on us because about half of it seems to be missing. (1) While research into this continues, observations tend to create more questions than answers. It’s typical to think that something is missing if you don’t find it, or, maybe it’s just somewhere where you didn’t think to look yet. An uneven distribution of baryonic matter and dark matter may explain a lot about what we think is missing, or what appears to be missing.

Low surface brightness galaxies appear to be good examples of unexpected uneven distribution of matter as described in the λCDM model. (2) Galaxy Malin 1 is a truly gigantic galaxy, 7 times wider than the Milky Way and with 50 times more mass, yet, Malin 1 has enough Dark Matter, (Galactic glue) to hold this huge structure together, it has so little baryonic matter that it is very dim and difficult to view.

Research revealed that Malin 1 is not all that uncommon of an example of unexpected distribution of the λCDM model, and recent observations have uncovered substantial numbers of low surface brightness galaxies (3) even though finding them is almost impossible because they are so dim.

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So is half the baryonic matter still missing, or is it simply distributed in ways we weren’t expecting? Maybe it is all clumped together somewhere else, like 9 pairs of my reading glasses in a forgotten drawer, yet to be discovered.

In other recent astronomical work, a different group of researchers think they have found possibly all of the missing baryonic matter. If they are correct, that’s big news. (4) An international team of researchers claims to have found the missing matter between galaxies in gas filaments known as warm-hot intergalactic medium or WHIM, (another 4 letter acronym that I may soon have to memorize).

This gas is super heated to 1.8 million degrees Fahrenheit by quasars, the super bright and very hot disks of matter spinning around super massive black holes. In their research, the astronomers used a quasar to backlight filaments of intergalactic gas and found oxygen in sufficient quantity that they believe, when extrapolated across the universe, is sufficient to account for all of the missing baryonic matter. Much more research is still needed to understand the processes for how quasars create the WHIM and if the WHIM really does account for all of the missing matter.

So the case of “the missing baryonic matter” might actually have been solved. Low surface brightness galaxies appear to support that some places have far less baryonic matter than typical galaxies, and places like intergalactic filaments appear to support that some places have much more baryonic matter than expected.

Combination of 4 NGVS images of Malin 1, obtained with MegaCam camera on CFHT. An indication of the size is given in the figure to show the amazing size of the disk of the galaxy (in comparison, the Milky Way has only a diameter around 30 kpc). Image Credit: Boissier/A&A/ESO/CFHT

And I just found another pair of missing glasses.

References:

Astronomy, Oct 2018, Taking a Dim View, Pg 45
Astronomy, Oct 2018, Taking a Dim View, Pg 48
Astronomy, Oct 2018, Taking a Dim View, the article.
Astronomy Oct 2018, Astronomers Identify Universe's Missing Matter, Pg 12

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Photo of the Month

M101 - Pinwheel Galaxy Distance: 23 million light years

Telescope Takahashi TOA-130F
Mount Takahashi EM200 Temma II
Camera QSI QSI 540wsg
Exposures: 19x10min Lum (bin 1x1), 4x5min each RGB (bin 2x2)

Data captured from my backyard in Las Cruces. Original data collected on 13 Feb 2013 and recently (this month) reprocessed.

Jeffrey O. Johnson

Credit: Jeffrey O. Johnson
http://jeffjastro.com

Photo of the Month

SH2-279 (NGC 1977, NGC 1973, NGC 1975)

I struggled with this one. There's lots of detail, but it hard to retain while increasing the image saturation--at least I had trouble with it. So, I resorted to the assistance of a couple of programs in addition to PixInsight: Gimp and something call Astra Image. The latter is useful for the easy interface, but is young and has some glitches...but the noise removal is really 'Oh So Fine." Suggest that you view it in a smallish format (1/3 size?)...not full screen. Anyway...happy Monday. Alex Woronow

OTA: RCOS (14.5" f/8) Camera: SBIG STX-16803 Observatory: Deep Sky West

EXPOSURES Red: 25 x 900 Blue 15 x 900 Green: 15x 900 Lum: 20 x 900 Hydrogen: 10X1800:

Total exposure ~24 hours Image Width: ~1/2 deg Processed by Alex Woronow using PixInsight (Gimp+Astra Image) in 2018

SH2-279 is an HII emission nebula (red) that also contains reflection nebulae (blue). This object is at the northern-most extent of "Orion's Sword" and the entire sword region, with is extensive array of nebulae, has be cataloged as Orion 1c. The source of ionization of the hydrogen is the young stellar object (YSO) 42 Orionis, which is the the topmost, and brightest of the three stars near the image center. The prominent and famous M42 nebula lies to the upper right of SH2-279, and some of it's distal parts are captured in this picture.