The Observer

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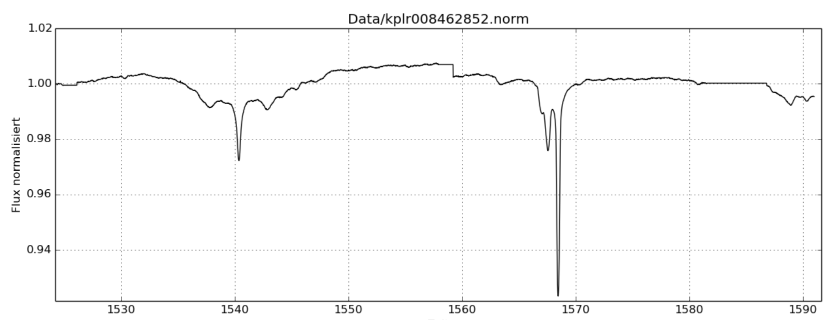
ad astra

One of the most intriguing mysteries in contemporary astronomy was the subject of out November meeting. Boyejian's Star, also known as Tabby's Star as well as the Where's the Flux star, is flickering occasionally, like a Christmas light that is loose in its broken socket, and nobody can explain why. Dr. Joshua Pepper from Lehigh University reviewed the findings and the potential explanations that have been proposed, none of which are considered very satisfying at the moment. This was a great presentation, because mysteries like this are the kind of thing that keeps science interesting, and it will be very cool to finally figure out what it is.



A portion of the mysterious light curve of Boyajian's Star

For now, I hope we are all looking forward to our upcoming Holiday party! This year we are going to try something new. I often join some work friends at Jack Callaghan's Ale House in Allentown for a fun night of competition, doing my best to dig the answers out of the back of my brain to questions that I previously had no reason to care about, and often learning something in the process. LVAAS' first Trivia Contest will take place at our Holiday party on December 10. Remember to bring some eats to share with your fellow attendees. Also remember to keep an eye on http://lvaas.org in case of bad weather, and we need to reschedule to December 11.

New-Year's To-Do's

Along with making resolutions, taking down the Holiday decorations, and starting a new file for 2017's receipts, don't forget to renew your LVAAS membership! Like a fire that needs fuel and oxygen to keep burning, LVAAS needs two things to keep generating the member benefits that we all enjoy: volunteer effort and revenue from dues. Now is the season for paying your dues for 2017. It only takes a few moments, so please don't let it slip through the cracks. Best bet: come to the Holiday Party and take care of it there.

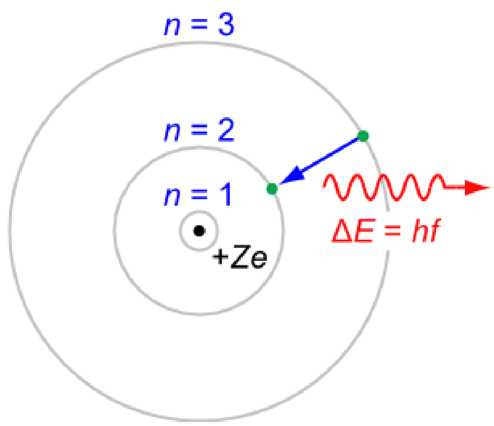
H-alpha the Red-Nosed Photon

If astronomers have a favorite color, it has to be that shade of red with the peculiar name pronounced "hydrogen

Sunset in H-alpha light

alpha," and written "H-alpha" or "Hα." It is light with a wavelength of 656.28 nm and it is prominent in emission nebula and solar prominences. The view of the sun through an H-alpha telescope is stunning.

Quantum Mechanics gives us an explanation of how H-alpha comes to be. According to QM, the behavior of an electron is governed by the wave equation of Schrödinger, and in a "bound system" such as a hydrogen atom, it can only have a certain discrete level of energy, primarily dependent on the principal quantum number n. When the electron transitions from n=3 to n=2, it emits a packet of energy corresponding to the difference: a photon of H-alpha light.



Traditional explanation of the creation of a photon, due to Niels Bohr

This is the story that I learned in college. The Schrödinger equation for the hydrogen atom takes into account the electrostatic field of the nucleus, and each solution is a function of position and time — $\Psi(\mathbf{r},t)$ — which tells what the electron is doing. The squared magnitude of the wave function, $\Psi^*\Psi$, is called the "probability density" and gives the likelihood of finding the electron at any particular point. It has solutions for certain energy levels or "orbitals", and it is the filling of these orbitals (around bigger nuclei, with more electrons) that give the various chemical elements their properties.

Another tidbit of Quantum Mechanics that I learned in college was that it is a "linear" system, which means that you can take any two valid solutions to the equation and combine them together, creating another equally valid solution in what is called a "superposition" of two energy-level states. Supposedly, this is what happens to the Cat in Schrödinger's famous and cruel "thought experiment." The idea is that QM cannot predict when certain things will happen, such as the decay of a radioactive atom, or when a hydrogen atom will emit one of those red photons. If we set up an experiment so that this event would lead to a larger consequence, one that we can observe with the naked eye, then the whole experiment will be in one of these superpositions — until we do observe it, and force it to make up its mind and choose one or the other. In the case of the kitty, you might say her position is not super, so to speak. If the uranium atom has not decayed yet, she is trapped in the box, waiting for the experiment to open the lid, and slowly running out of air. If the decay has occurred, her troubles are over and she is in kitty heaven. But until the lid is opened and the experimenter takes a look at her, in some way she is both.

Schrödinger devised this imaginary scenario in order to illustrate what he considered to be a problem with quantum science; the idea of a cat that was both alive and dead at the same time seemed too ridiculous to be seriously entertained. Instead, for many scientists, it was accepted as probably accurate and it became an exemplar of how strange the quantum realm can be. This was the Quantum Mechanics that was taught in school when I studied it. But over the years, something about it began to bother me.

If a cat can be in such a superposition of two different states of being, then why not a hydrogen atom? Using the “bra-ket” notation of Dirac, the n=2 and n=3 solutions for Ψ are written "$|2\rangle$" and "$|3\rangle$" (pronounced "two-ket" and "three-ket"), and the transition between these two states is associated with the generation or absorption of an H-alpha photon. But what about a superposition, for example, $(|2\rangle + |3\rangle)/\sqrt{2}$? (We are required to divide by $\sqrt{2}$ so that all the probabilities still add up to 1.) Can you get an atom into this state, and if so, how? I realized that I did not know QM well enough to understand why, if superpositions are valid solutions, we only see the transitions between the discrete energy levels.

Stationary states

Digging deeper, I worked on relearning some of the finer points of QM and continued to think about this puzzle. The detail that finally made it clear for me was that the discrete energy solutions, or “energy Eigenstates,” of a quantum system have another name: they are called “stationary states.” But what exactly is stationary about them?

It gets back to Ψ being a complex-valued function, which you can represent either as the sum of an ordinary real number and an “imaginary” one, a multiple of the very useful *i* which is defined to be the square root of -1; or as an arrow pointing outward from the origin of a two-dimensional graph. The position of the end of the arrow could be described by the Cartesian coordinates which are the “real” and “imaginary” part of the complex number; or they can be described in polar coordinates with a length, or radius, and an angle. In the wave function the radius is the “amplitude” and the angle is the “phase.” And in a pure-energy state, the amplitude is constant, and only the phase varies in time, racing around the origin with a frequency corresponding to the energy of the state.

Here’s where “stationary” comes in: to figure out where you are likely to find the electron, you calculate the “probability density” $\Psi^*\Psi$, which is only dependent on the amplitude. And for an energy eigenstate, the phase races around its circle with some frequency ω, but the radius, or amplitude does not vary in time. So the probability distribution does not move; it is stationary.

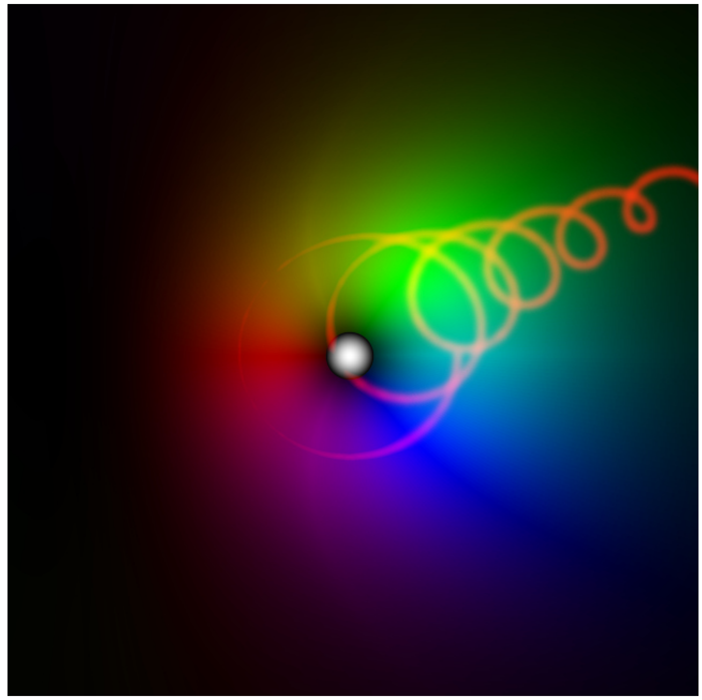
But what if, for the purposes of interaction with the EM field, $\Psi^*\Psi$ is more than just a probability? Suppose it deterministically represents the electron, as a distributed cloud of electric charge? If the cloud is stationary, it does not radiate energy. The electron is sitting quietly in its orbital, stable until something disturbs it.

But if the electron is in a superposition of two energy states, $|2\rangle$ and $|3\rangle$, with frequencies ω_2 and ω_3, then it oscillates, with a certain frequency, and that frequency is the arithmetical difference, $\omega_3-\omega_2$.

This was the key piece of the puzzle for me. In quantum physics, frequency is energy and energy is frequency; and this is the same for electrons and for photons. An electron in state $|3\rangle$ has a wave function that rotates in phase at frequency ω_3, and appears stationary to the EM field. An electron in state $|2\rangle$ rotates at ω_2 and also seems stationary. But as an electron transitions from $|3\rangle$ to $|2\rangle$, it must pass through the superposition states, vibrating at the frequency $\omega_3-\omega_2$, and in the process creating a photon with frequency $\omega_3-\omega_2$. This understanding transforms the interaction between an electron and a photon, from a magical and instantaneous "quantum jump" that just happens because the laws say that it must, to a continuous, smooth process that can be understood to evolve like any other physical system.

In my mind's eye, here is how I see it: the electron starts off in |3⟩ like a perfectly symmetrical, perfectly polished, perfectly balanced flywheel, a shiny little ball of electric charge that is spinning so smoothly that you can't tell it's moving at all. But given tiniest disturbance, something changes: the state is no longer pure |3⟩ but now has a tiny bit of |2⟩ in it. It is no longer spinning true; it starts to wobble, ever so slightly, and in the process it starts to radiate. A packet of electromagnetic energy begins to stream forth, with frequency $\omega_3 - \omega_2$, the beginning of a H-alpha photon being created.

As the electron contributes more and more energy to the photon, the proportion of the quantum state which is |3⟩ decreases, and |2⟩ increases, and the wobbling intensifies. When they are equal the wobbling reaches its maximum and the peak of the photon wave packet is being emitted. As the process continues, the electron settles down into |2⟩ and becomes stable once again. Once more, it is spinning true — smooth and stable; and the newborn H-alpha photon is complete and on its way.



A hydrogen-alpha photon in the process of being created by a hydrogen atom, which is in a superposition of n=2 and n=3 states. For an animation of this model, see

http://lvaas.org/lnk/pk21a

To where? Inevitably, to another electron somewhere, perhaps of another hydrogen atom, or perhaps in a different sort of bound electron state in a semiconductor crystal, such as one belonging to an LVAAS astroimager. Its life can only end by interacting with another charged particle, causing it to transition between two energy levels, with frequencies that differ by the same amount. The leading wiggles of the photonic wave train disturb the lower-level state, which edges into a another wobbling superposition that resonates with the incoming waves. Each new crest of the wave reinforces the wobble at just the right time, pumping more and more energy it, moving it farther and farther out of the lower energy level and into the higher one. By the time the last wiggle of the photon is absorbed by the atom, it has exactly just enough energy to stabilize into the higher state. It is a very neat, pretty picture of how atoms and photons work, that if you close your eyes real tight and try real hard, almost seems possible.

Honk If You Believe

A hydrogen atom in the n=3 or |3⟩ state could hold on to that energy for a long time, but as we have imagined, it only takes a little push to make it give it up in the form of a little packet of red light. The reverse process requires the photon to come across another atom in the |2⟩ state just right, so that it can be absorbed. I find it hard to imagine this happening very often, unless there is a virtual river of photons washing across such an atom; then it would very easily pluck one out of the stream. But this makes me wonder about photons. If there is a river of photons, it would seem possible for the atom to pick half of one photon and half of another, or to just absorb a photon's worth of energy from the stream, with no need to worry about whether they were photons to begin with. So, are photons really a fundamental characteristic of light?

It turns out that if we look carefully, we can find that all of the particle-like features that we understand to be intrinsic to light could instead be artifacts of the way that light interacts with electrons. Photons might not be "real" in the sense that they are not independent "things," but more like convenient units of measurement in the generation or absorption of light. The question doesn't seem to be really settled, and physicists are still thinking of experiments to test it, and it seems to be going around in a circle: somebody does an experiment that appears to prove that photons have an independent existence, and then somebody else demonstrates that the experiment proves nothing of the sort, because you can construct such-and-such a photon-less version of electrodynamics that explains the same result. Fundamentally, we know that we can only detect light in photon-sized chunks, but we can't seem to prove that light can only exist as photons, and in fact the mainstream physics community increasingly seems to believe that it doesn't.

For example, few weeks ago I heard Ohio State physicist Dr. Michael Lisa give a talk over at Lehigh about Hanbury Brown and Twiss, which I previously would have guessed to be an overpriced brand of gourmet caramels or something like that. The HBT effect is of interest to astronomers because its first application was for measuring the diameter of certain celestial objects, notably Sirius in 1958. In the process of explaining this phenomenon, Dr. Lisa made a statement that reinforced what I have learned about this topic. "Photons do not travel through space," he said. "Waves travel. Photons are just the events of generating or detecting the waves."

I even think it is possible that this is a moot question. Maybe someday we will have a complete and consistent theory of the Universe and all the forms of matter and energy that it contains, and it will provide a final answer to this question. But this answer won't be that photons are real things, fundamental to the electromagnetic field. Neither will it be, that photons are just epiphenomena of the interaction of light with charged particles, as we have described here. Instead, it may be that the question is "philosophical" and that the physical answer is that we can have it either way, and we always will, because there is no experiment that could rule out either possibility.

I hope this is not the way it turns out, though. I want a Theory of Everything that is complete and consistent, but I also want it to be "ontologically satisfying" — in other words, if photons are real, I can handle that, and if they aren't, I can handle that as well; but I really want them to end up, at some point in the future, one or the other and not stuck in between. But regardless, that reckoning is probably far in the future, with a lot of difficult and exciting physics required to get there; and in the meantime, the photons will keep arriving from deep space for a lot of great astronomy as well. Ad Astra!

— *Rich Hogg*

Image credits: Boyajian's Star light curve: By JohnPassos - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=46685218; Sunset in H-Alpha-Light by Michael Karrer https://www.flickr.com/photos/michael_karrer/126589006 CC BY-NC 2.0 https://creativecommons.org/licenses/by-nc/2.0/; Bohr Atom https://en.wikipedia.org/wiki/H-alpha#/media/File:Bohr-atom-PAR.svg By JabberWok at the English language Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2639910

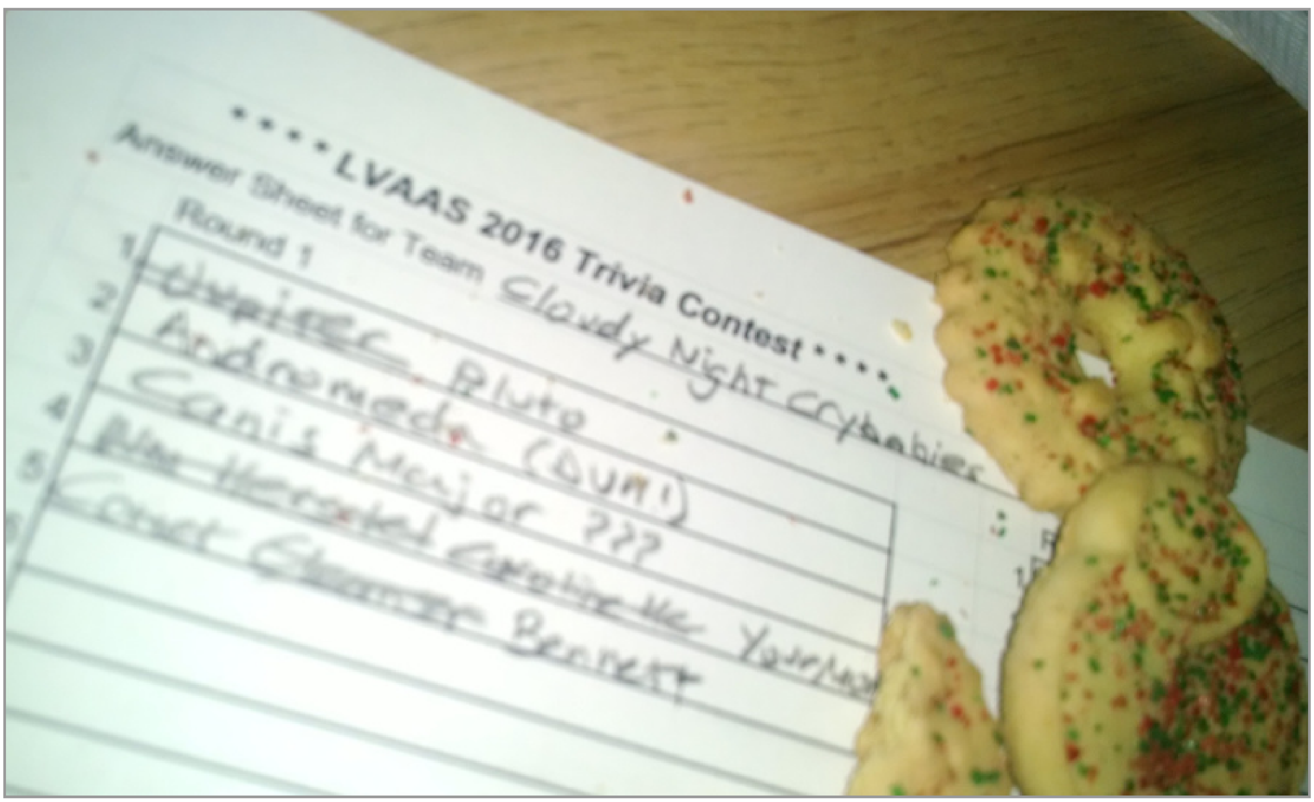
General Meeting and Holiday Party

Grace Community Church, 1290 Minesite Road, Allentown, PA

Saturday, December 10, 2 p.m.

Snow date is Sunday December 11; check website for updates.

Get ready for some Holiday cheer and brain-teasing fun! Bring a dish or dessert to share in seasonal celebration with your Astronomical fellows. Also sharpen your pencils (and your brains) for the first-ever LVAAS trivia contest, featuring Dave Melman, host of Wednesday Trivia Night at Jack Callaghan's Ale House. And start thinking of a funny name for your team! (The best one is worth an extra point.)



Members and guests will form teams of up to 6 players and answer 5 rounds of 10 questions each. Prizes will be awarded for first, second, and third place.

Directions to Grace Community Church:
http://www.churchangel.com/map/grace-community-church-allentown-pa-18103.html

COME JOIN THE FUN!

2017

Will Be Here Before You Know It!

It's time to break out the checkbook, update your information, and renew your LVAAS membership.

Please download the renewal form from this link:

http://lvaas.org/filemgmt_data/files/LVAAS2017MembershipRenewalForm.pdf

And send it, with your check, to:

LVAAS

ATTN: Membership

620 B East Rock Road

Allentown, PA 18103-7525

Minutes for the LVAAS General Meeting of 13 November 2016

The November General Meeting was held at our South Mountain headquarters in Allentown, PA. The meeting started just after 2:00 p.m. Director Rich Hogg made a few quick announcements. He cautioned members to go easy on the use of the toilet due to a low cistern level from lack of rain. He also announced that LVAAS clothing for sale in the Red Shift Store would not be available after this meeting since the meetings for December through March would be off site. Lastly he announced that the 2017 LVAAS calendars had arrived and were for sale for $20. Due to the absence of Programs Director Sandy Mesics, he then introduced the speaker, Dr. Joshua Pepper, Professor of Physics at Lehigh University.

The title of Dr. Pepper’s presentation was "The Mysterious Case of Boyajian’s Star, (nee Tabby’s Star)." Boyajian’s star, officially known as KIC8462852, was one of the stars monitored by the Kepler Space Telescope for possible exoplanet transits. Its very unusual light curves were discovered by citizen scientists and investigated by Yale astronomer Tabetha Boyajian. Boyajian’s star, as it more properly should be called, is a rather typical F class main sequence star. But the drops in its light curves are not symmetric, nor are they systematic as would be the case for an exoplanet transit. Additionally, the changes in intensity of the drops in light are extraordinarily large. Dr. Pepper discussed the numerous possible causes, but to date no one knows what is causing these extremely unusual light curves. Scientist are actively monitoring this star for its next dip in light and then a whole host of tools will be put to the task of further characterizing this apparently unique star. The program and questions completed at 3:22 p.m., and about 3:30 p.m. Rich began the usual information session.

As acting Membership Director, Rich conducted new member readings. David Yannerell and Barry Huett were recognized for their first readings. There were no second readings. Additionally, Rich announced that Scott Fowler would be assuming the position of Membership Director once his term as Treasurer completed the end of November. Additionally he announced that 2017 dues were now payable.

Rich also announced that effective the end of November, Chuck and Donna Bradbury would be resigning as co-directors of the Red Shift Store. Rich thanked them for their two-year service in this position. This position is now open for a volunteer. Carol Kiely mentioned that the next Lunatics and Star Gazers Evening would meet on December 2nd, and the next public star party would be held on December 3rd.

Lastly, the next General Meeting, the annual Holiday Party, will be held at 2:00 p.m. on Saturday, December 10th, at Grace Community Church. The January General Meeting will be held 2:00 p.m. on Sunday, January 8th, at Muhlenberg College.

The meeting adjourned at 3:50 p.m.

Minutes prepared and submitted by Ron Kunkel, Secretary.

HELP WANTED: No Experience Necessary. Operate/manage small retail establishment. Manage inventory and purchasing of beverages, snacks, hot dogs, custom-branded apparel and SWAG, and astronomy-related curiosities and media. Staff retail counter at Star Parties and General Meetings, or coordinate volunteers to do same. Procure and distribute beverages at Christmas Party, same plus additional staples at annual Picnic. Account for revenue, expenses, and profits, and report to owning organization. * * * The Red Shift needs a new proprietor!!! * * * Position opening in December. Apply in person or by e-mail to director@lvaas.org *

*** LVAAS calendars will be sold at general meetings held at Muhlenberg College over the winter months.**

LVAAS Astrophotography Calendar 2017

The LVAAS 2017 calendar is now available for purchase at all general membership meetings. Please visit the LVAAS website for more information about purchasing the calendar. All proceeds benefit the LVAAS Greater Lehigh Valley educational outreach program.

Thanks to everyone who helped make our calendar happen again this year!
- Sandra Repash, Calendar Editor

Calendar Cover Photo Credit: Gary A. Becker

Deadline approaching...

Hello Everyone,
I've given talks at your astronomy clubs regarding my experiences visiting large observatories in Chile through the ***Astronomy in Chile Educator Ambassadors Program (ACEAP)****. This exciting opportunity is now officially open for new applicants. Please share the following with your membership. I'd be happy to answer any questions you have or you can contact Tim Spuck, who is the coordinator for the program. This is an amazing experience to work with wonderful people, visit incredible facilities, and learn and share how modern astronomy is done today.*
Best wishes and good luck to all the applicants!
Peter (Detterline)

Dear Potential ACEAP Applicant,

The Astronomy in Chile Educator Ambassadors Program (ACEAP) has been an incredible success these past 2 years. To date 18 astronomy educators (formal and informal) from across the US and its territories have traveled to Chile for this amazing experience, and these individuals have paved the road for what we all hope will be an enduring program for years to come.

We are in the process of seeking the necessary funds to continue ACEAP, however to date funding has not yet been secured for ACEAP 2017, and it is unlikely we will have confirmation of funding until February 2017 or later. Please know that the ACEAP Leadership Team is committed to exploring avenues to keep the program going, and we believe the success of ACEAP 2015/2016 significantly increase the likelihood of continued funding from NSF, but there are no guarantees. Depending on funding, ACEAP 2017 may not take place at all, or may be altered significantly from ACEAP 2016/15.

With this understanding, we are opening the application process for ACEAP 2017. Although there is a level of uncertainty, it is necessary to move forward with the application process if we are to adequately plan for the selection of a 2017 Cohort and a 2017 Expedition. All applications must be submitted online at https://www.surveymonkey.com/r/ACEAP2017 by 11:59 PM (your local time) on Sunday, January 22, 2017. Again, please keep the uncertainties about ACEAP's future in mind as you consider applying for ACEAP 2017. As soon as we have any news on future funding, we will share it with you and the rest of the community.

To learn more about ACEAP or to apply to ACEAP 2017 please visits our website at https://public.nrao.edu/look-deeper/aceap or visit us on Facebook at https://www.facebook.com/AstronomyAmbassadorsProgram/.

Thank you so very much for your time and consideration, and your understanding and patience as we work to secure future funding for ACEAP 2017 and beyond. If you have any questions, please direct them to Mary Mayo (ACEAP Program Administrator) at mmayo@nrao.edu, Tim Spuck (ACEAP PI) at tspuck@aui.edu, or Charles Blue (ACEAP Co-PI) at cblue@nrao.edu.

Sincerely,

Tim and the ACEAP Leadership Team

IC434 Horsehead and NGC 2024 Flame Nebulas

By Tom Duff

Image captured September 4, 2016 at the Black Forest Star Party, Cherry Springs State Park by LVAAS astronomer and astroimaging group coordinator Tom Duff, using a Stellarvue 105mm telescope, Atik 383L One Shot Color camera, with Nebulosity 4 imaging software, PHD2 Guiding software, and image processing in Nebulosity 4 and Adobe Photoshop.

Ron's Ramblings

Ron's Ramblings is a monthly series of articles describing some recent or otherwise important event in astronomy. The ramblings will attempt to describe both the astronomical event and its significance. Obviously, the description will be that of a rambling amateur astronomer.

Evidence for New Ninth Planet

The evidence continues to mount for the existence of a new ninth planet in our Solar System. But this planet is unlike any current planet as it is hypothesized to reside in the far-distant reaches of the Solar System, way out beyond the Kuiper Belt, the location of the former ninth planet, Pluto. No less than five different pieces of evidence now offers support for the existence this new ninth planet. In this article I will briefly summarize the evidence. Its discovery remains to be confirmed.

The story begins with the discovery of the object officially known as 90377 Sedna, which was discovered in November of 2003. Its orbit varies from 76 to 937 AU from the Sun and takes roughly 11,400 years for one orbit. In comparison, Pluto's orbit varies from 29 to 49 AU with an orbital period of 248 years. The discovery of Sedna was a true enigma for planetary scientist.

In 2014 Sheppard and Trujillo announced the discovery of the object know as 2012 VP113, nicknamed "Biden". Its orbit varies from 80 to 438 AU from the Sun and takes 4176 years for one orbit. And they noticed that both Sedna and 2012 VP113 made their approaches to the Sun at similar angles. This could mean that something massive, such as an unknown planet, was defining the orbits of both objects.

Forward to January 2016. Batygin and Brown, from Caltech, based on the announcement of the discovery of yet additional distant objects similarly tilted to the plane and with similar perihelia, published a paper hypothesizing the size and orbit of the new ninth planet. They estimated that Planet Nine would weight about 10 Earth masses and take somewhere between 10,000 and 20,000 years to orbit the Sun; its distance from the Sun ranging from 200 to 1200 AU.

In June of 2016, Renu Malhotra, of the University of Arizona, after analyzing the orbits of the four longest period Kuiper Belt Objects, announced that these objects have integer resonance periods with one another. This further suggests that they are being pulled into these resonances by a massive object. She estimates its mass at 10 Earth-masses, and that it would take 17,000 years to orbit the Sun, eerily similar to the prediction of Batygin and Brown. Her calculations even indicate where in it's orbit this object should now be located.

Additionally, in July of 2016 Bailey, Batygin, and Brown, suggest that even the 6-degrees tilt of the solar system's planets' orbits relative to the Sun's spin-axis might also be explained by the putative Ninth Planet. Thus, the putative Planet Nine would explain the long-standing mystery of the spin-orbit misalignment of the Solar System.

Not all astronomers are convinced that all this evidence points to a Ninth Planet, but to quote Katherine Volk, University of Arizona. “The fact that there are multiple things probably says something is happening.” With all of the mounting evidence and the large number of astronomers looking for this object, I wouldn’t be surprised if astronomers had already discovered this object, but have not yet announced its discovery.

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Solar obliquity induced by Planet Nine. (2016, November 1). Retrieved from https://arxiv.org/abs/1607.03963

The end of my ramblings until next month. Ron Kunkel

What's Happening at Pulpit Rock

LVAAS's many observatories and grounds at Pulpit Rock and South Mountain require rigorous maintenance, and many renovations are currently being planned and executed. Members willing to devote their time and energy to help keep our facilities in top working order, please watch for e-mail announcements, and watch this space for updates on work in progress or being planned. Per ardua ad astra! Photo of Pulpit Rock Astronomical Park by Gary A. Becker.

Scout Weekend Nov 11-13, 2016

Foreground is Troop 31 from Chadds Ford PA, and the one on the other side of the road is Troop 187 from Dublin PA. Contributed by Tom Applebach and Ron Kunkel

StarWatch

by Gary A. Becker

Arrival

In the space movie fare which has produced some provocative viewing in the last several decades, such as ***Contact***, ***Red Planet***, ***The Martian***, and ***Interstellar*** comes another appealing film called ***Arrival*** which is currently playing in local theaters.

Starring Amy Adams as Louise Banks, a linguistics expert, and Jeremy Renner as her physicist partner, Ian Donnelly, the two set off to understand the language of an alien race that has made its presence known to humanity by arriving at 12 unrelated locations across Earth in black, flattened, dirigible-style spacecrafts that hover nose-first just above the ground.

Even before the investigation begins, the viewer gets a sense that Louise is different, hiding an unsettling secret that overwhelms her being. This promotes an immediate sense of angst from the film's get-go which percolates and heightens during the lead-up when contact is finally made with the aliens. The spacefarers are huge octopi-like creatures, communicating in a pictorial language drawn within the cloud-filled chamber in which they reside. Progress is slow, maybe too slow for most audiences, but the trepidation lasts. "What is really going on here? What's the big picture?"

While Louise and specialists across the world are deciphering the language, the Rosetta moment occurs when the aliens tell Louise to "use weapons." Then the unthinkable happens. A coup within the US military tries to destroy the "egg" while Louise is communicating with the aliens. The octopi sacrifice one of their own to save Louise, while at the same time the world is screaming their slogan to "use weapons."

The key to understanding ***Arrival*** is to be able to think in a nonlinear fashion. In ***Arrival***, "C" does not follow "B" and "B" does not follow "A." The film is a puzzle of pieces which must be crafted into a whole by the viewer. Both Louise and the octopi have a special gift, concerning time and the future. For this feature film which produces such a heightened sense of tension throughout its discourse, ***Arrival's*** conclusion is both positive and full of promise.

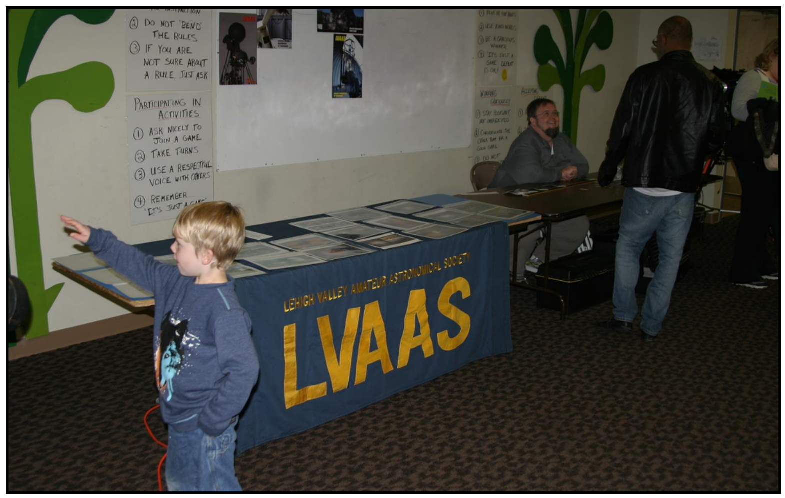
Arrival theatrical release poster by Paramount Pictures.

© **Gary A. Becker –** beckerg@moravian.edu **or** garyabecker@gmail.com
Moravian College Astronomy - astronomy.org

LVAAS Visits Seven Generations School Science and Technology Night 11/19/2016

Eric Loch shows some budding astronomers the basic set-up for astroimaging at the SG charter school in Emmaus, which educates children from grades one through six. The trio set up three telescopes for the public to use.

Rich Hogg (background, sitting behind table) answers questions about astronomy from folks stopping by the LVAAS display, as a child finds something of interest.



The LVAAS display consisted of printed images from the Hubble Telescope, as well as various astronomy games conducted by Rich, Eric and Ron Kunkel (standing behind table.)

Thanks to our dedicated representatives who help foster an interest in astronomy by participating in these community events!

From the LVAAS Archives:

Joy and Loss in 1966

By Sandy Mesics

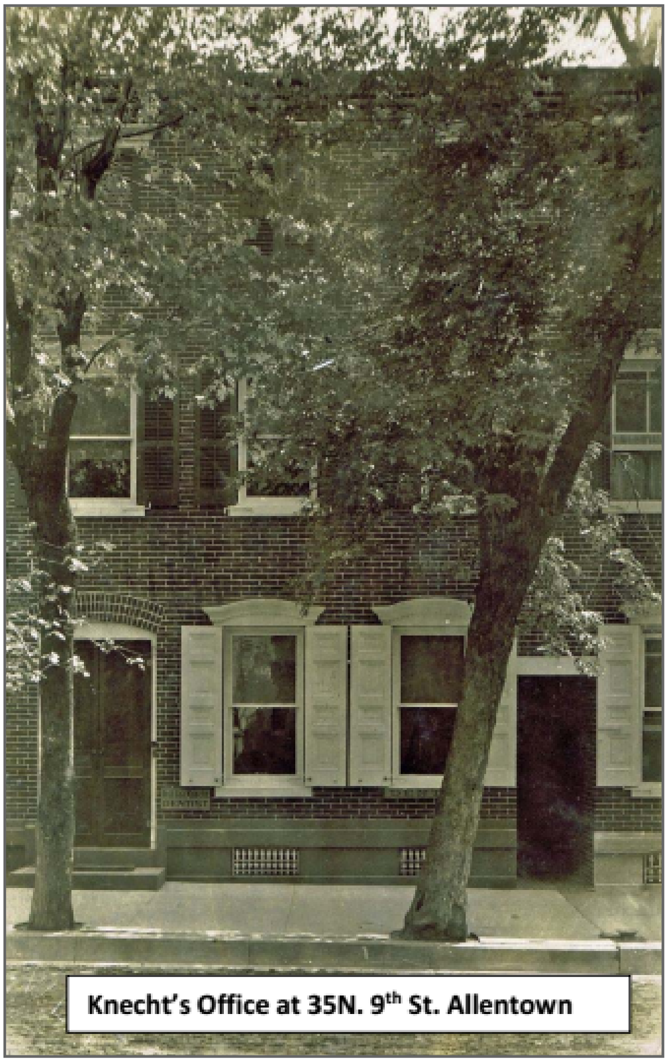
At the December 4, 1966 general meeting, the 1967 officers were sworn in: Director: Ernest Robson, Assistant Director: George Maurer, Secretary: Paul Shenkle, and Treasurer: Bruce Gardner. Following the swearing in of the new officers, a brief business meeting was held, during which LVAAS life member Gary Becker had his first reading for membership. After this brief meeting, members enjoyed the traditional LVAAS holiday party, held in the planetarium.

Amid this joyous time, there was also sadness. The next day, Dr. D. George Knecht passed away at age 90. Many members know we have a Knecht Observatory at South Mountain housing a 6-inch refractor, but few members know the story of the man who organized amateur astronomy in the Lehigh Valley in 1927.

D. George Knecht was born on 6 April 1876 at Sand Spring, a hamlet east of Schnecksville, Lehigh County, Pennsylvania. When he was four, his family moved to Neffsville, where he began his primary schooling. When he was eight or nine years of age, he began tinkering with clocks. This led to a lifelong hobby of collecting and repairing clocks. At twelve years of age, Knecht began working on neighboring farms, and his education, for the time being, came to a halt. In 1894 Knecht went to Allentown to assist Dr.A.S. Rabenold in his work in dentistry.

The young Knecht became interested in the profession and began studying anatomy, physiology, chemistry and the like in the doctor's books. While walking through Center Square one evening, Knecht met a dignified old man in a Prince Albert coat and skull cap, who was offering people a look through his telescope for a dime. Knecht paid his dime, and looked at Saturn. That made such an impression on him that it sparked a lifelong interest in the starry heavens.

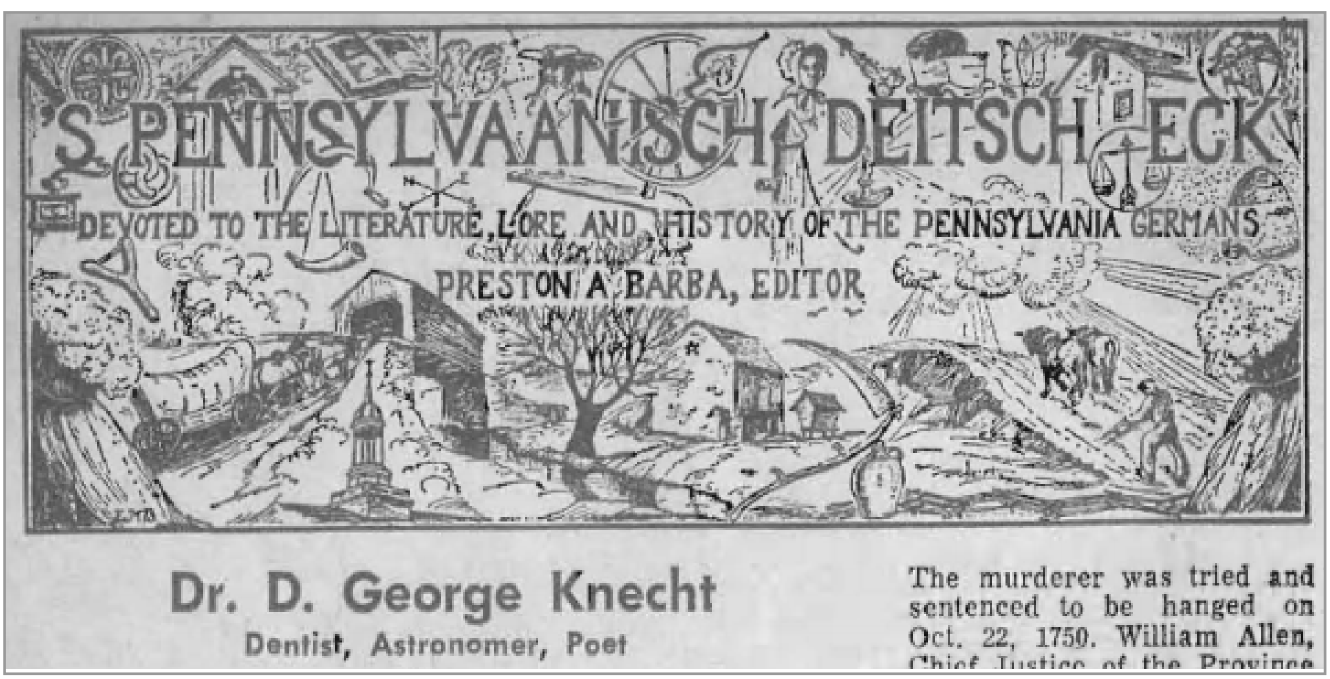
In 1897, Knecht entered the Pennsylvania College of Dental Surgery in Philadelphia, graduating in 1890. He returned to Allentown where he practiced dentistry at 9th and Hamilton Streets until his retirement in 1963, at the age of 86.



Knecht's Office at 35N. 9th St. Allentown

At dental college, Knecht purchased two used astronomy books, which sparked his interest in both astronomy and telescope making. Over the years he constructed over a dozen telescopes, and gave about ten of them away. As the story goes, in 1927, about the time Knecht had finished building his first telescope, a young Ralph Schlegel visited Dr. Knecht for some dental work, and they began talking about astronomy and telescope making. A lifetime friendship formed, and a byproduct of that friendship became the Lehigh Valley Astronomical Society (LVAS), which they helped found in 1936. This group would be the precursor of LVAAS.

Another of his loves was writing poetry. In later years, Knecht began writing Pennsylvania German poems, sending them to Preston A. Barba, who published them in his "Eck" at irregular intervals, but quite consistently throughout the life of the column. "Eens fer mich, eens for dich" is an example of Knecht's ability to tell a story in verse. It appeared first in the "Eck" on 21 November 1953.



'S PENNSYLVAANISCH DEITSCH ECK

DEVOTED TO THE LITERATURE, LORE AND HISTORY OF THE PENNSYLVANIA GERMANS

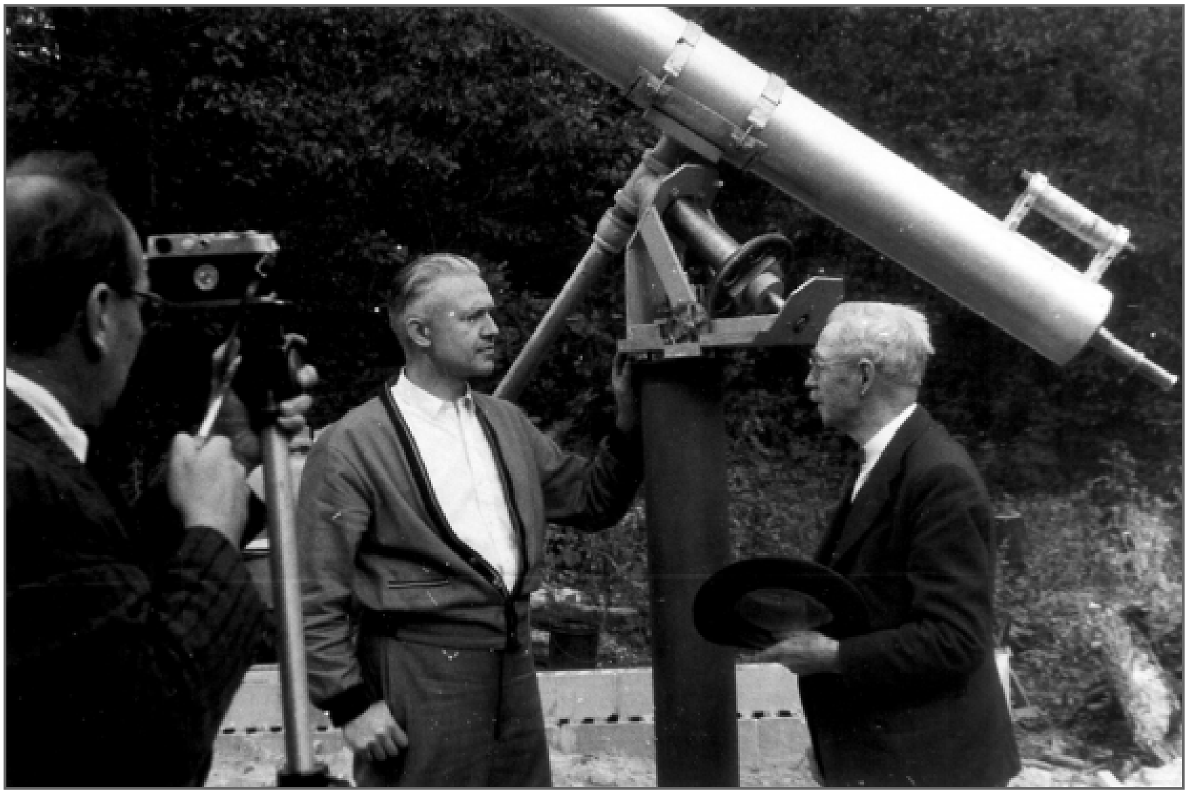
PRESTON A. BARBA, EDITOR

Dr. D. George Knecht

Dentist, Astronomer, Poet

The murderer was tried and sentenced to be hanged on Oct. 22, 1750. William Allen, Chief Justice of the Province

Knecht married Miss Hanna Traub of Allentown on Friday, October 25, 1901, in the home of the bride's parents. The couple had one daughter, Alice, born in 1903. Hanna died unexpectedly in 1942 when she was visiting their daughter, Alice Jones in Easton.



One of Knecht's best telescope-making efforts was a 6-inch refractor, for which he ground and polished the optics. When LVAAS began construction of the South Mountain headquarters, Knecht donated this scope to LVAAS. It was installed in the newly built Knecht Observatory. Over the years, most of the components of this scope have been changed: the optics have been replaced by commercially-made lenses, and the mount has been changed as well. But the observatory still bears the name of this "renaissance man" who contributed so much to the advancement of amateur astronomy.

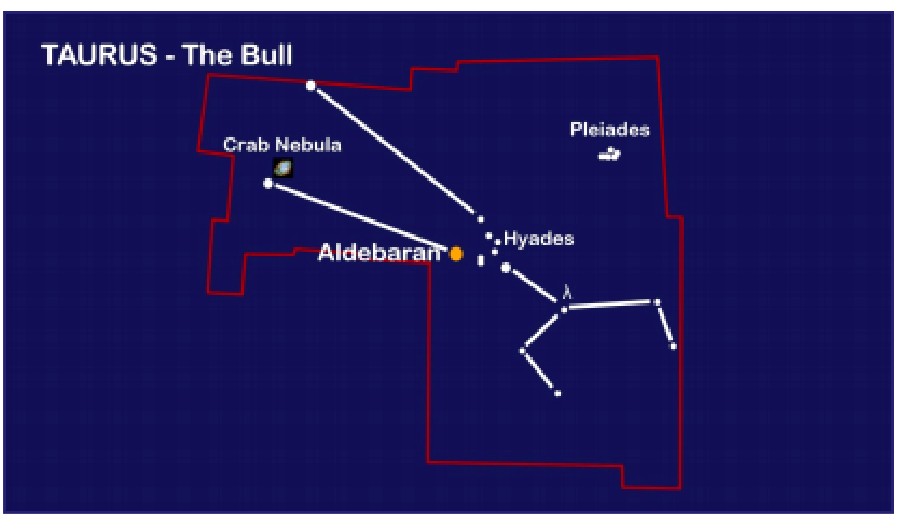
Highlights of the December Sky

by

Carol Kiely

The Pleiades, or M45, is probably the finest of all the open clusters in the night sky. This time of year, just after sunset, it can be seen with the naked eye in the eastern sky. However, by far the best way to view it is through a pair of binoculars. Despite being some 440 light years from Earth, the reason why this cluster is so bright is that it is dominated by some relatively young (100 million year-old), very luminous, blue stars (B-type stars). As with all open clusters, theses stars are moving away from each other. In 300 million years or so they will no longer be part of a cluster. Currently, some of the stars are passing through clouds of interstellar dust which reflect the blue light making the view even more spectacular.

Lower down in the eastern sky you will see another open cluster, the Hyades. As with the Pleiades, this star cluster is best viewed using a pair of binoculars because it covers such a large area of the sky. The Hyades is one of the closest open clusters to Earth, at a distance of 151 light years. The stars in this cluster are much older than those of the Pleiades. They are estimated to be about 625 million years old. The main stars form a V-shape which represents the head of Taurus, the bull.



The bright star on the eastern tip of the V is Aldebaran. This red giant is not a part of the cluster at all. In fact this star is much closer to Earth - it is a mere 65 light years away. As with all red giants, Aldebaran has exhausted the hydrogen in its core and has begun to pulsate erratically which leads to an irregular change in apparent magnitude from 0.75 to 0.95. Scientists have also determined that this star is rotating very slowly - it takes two years to make one revolution; our Sun takes 25 days.

One of my pet projects at the moment is to help star party visitors realize that when they stargaze they are looking back in time. A light year is the distance light travels in one year (roughly 6 trillion miles). Therefore as Aldebaran is 65 light years away, it has taken 65 years for the light from that star to reach us. So for all you 65 year-olds, when you look at this star, you are looking at the light emitted on the year you were born - **Aldebaran is your Birthday Star!**

The V-shape in Taurus can also be used to find λ-Tauri, an eclipsing binary very similar to Algol in Perseus. Simply use the V as a pointer and the next bright star you come to is λ-Tauri. Every 3 days and 23 hours, its apparent magnitude drops from 3.4 to 3.9. This is when the dimmer star passes in front of brighter one. The eclipse lasts for approximately 14 hours.

Taurus also houses the remnants of a supernova - the explosion which occurs when a supergiant star dies. In the summer of 1054, Chinese astronomers saw a star that had suddenly become as bright as the full moon. Records show it was visible in the daytime for at least three weeks. It could also be seen for the following two years at night with the naked eye. When a supergiant star like this one comes to the end of it life, its central iron core collapses to form an extremely dense core made almost entirely of neutrons. The outer regions of the star also implode, but when they hit the rigid core they are immediately flung back into outer space. This releases massive amounts of energy some of which is emitted in the form of light which is what the Chinese astronomers saw. The debris from this explosion is still dispersing and we call it The Crab Nebula. At its center is a spinning neutron star (or pulsar), an intense emitter of electromagnetic radiation covering the whole range of wavelengths from radio to gamma waves.

And now for a bit of lunacy..............

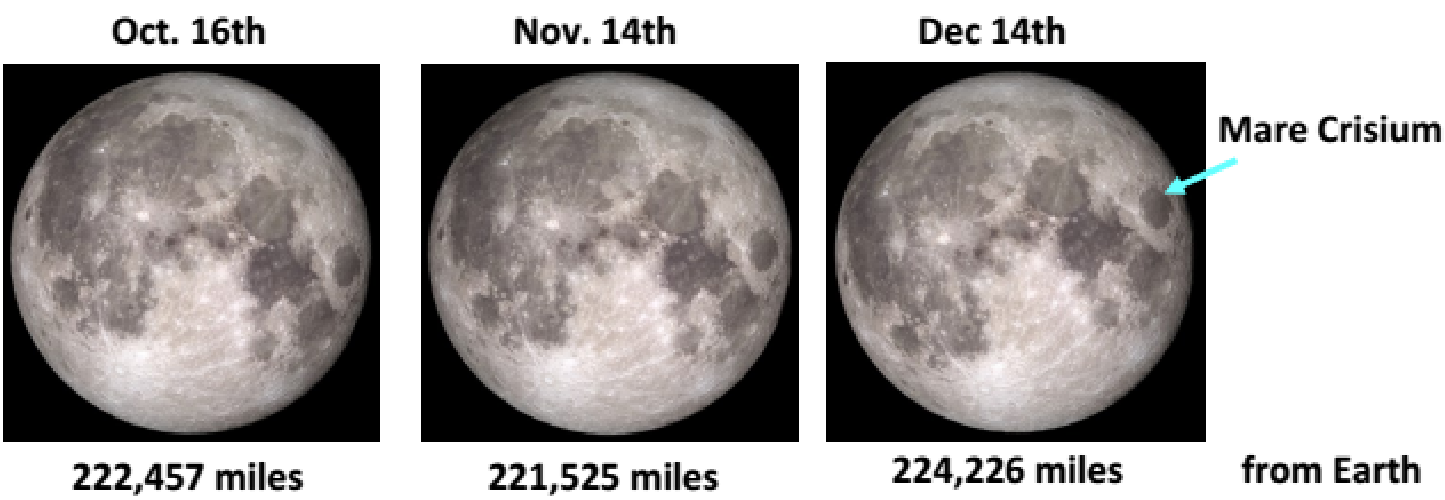


Image and data credit: **the NASA/ Goddard Space Flight Center Scientific Visualization Studio**

This month, on December 14th, there will be another supermoon - that’s three in a row! The moon will not come as close to Earth as it did last month, but it can still be classed as a supermoon. Above are simulations of each of the supermoons. Notice the change in the position of Mare Crisium. This is a really nice example of optical libration due to the variation of the lunar orbit. Unfortunately, the timing of the full moon will coincide with the Geminid meteor shower so we won’t see as many shooting stars this year, if any. The good thing is that the winter constellations will soon be in full view - I can’t wait.

Happy Stargazing!

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

Dimming stars, erupting plasma, and beautiful nebulae

By Marcus Woo

Boasting intricate patterns and translucent colors, planetary nebulae are among the most beautiful sights in the universe. How they got their shapes is complicated, but astronomers think they've solved part of the mystery—with giant blobs of plasma shooting through space at half a million miles per hour.

Planetary nebulae are shells of gas and dust blown off from a dying, giant star. Most nebulae aren't spherical, but can have multiple lobes extending from opposite sides— possibly generated by powerful jets erupting from the star.

Using the Hubble Space Telescope, astronomers discovered blobs of plasma that could form some of these lobes. "We're quite excited about this," says Raghvendra Sahai, an astronomer at NASA's Jet Propulsion Laboratory. "Nobody has really been able to come up with a good argument for why we have multipolar nebulae."

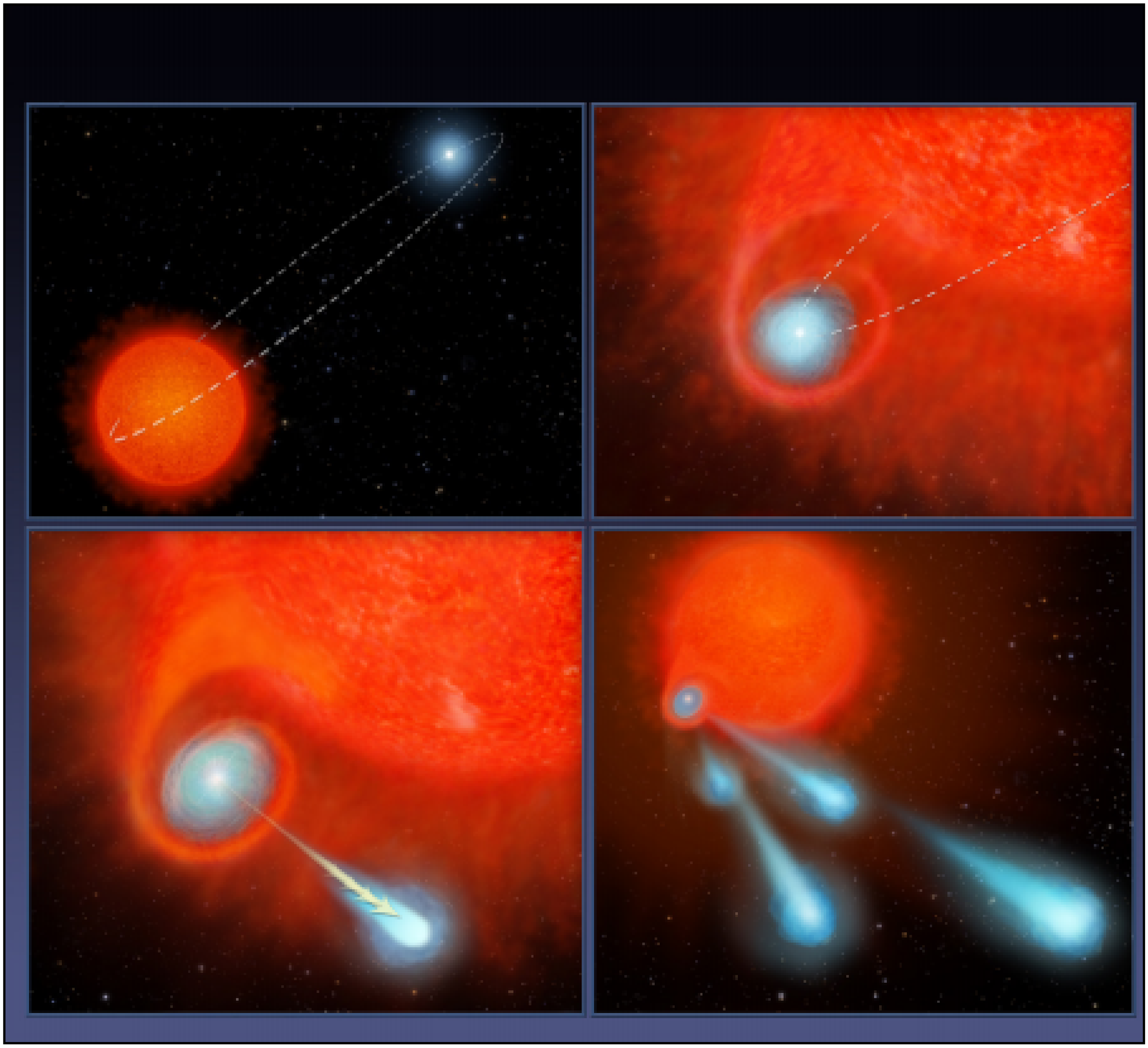
Sahai and his team discovered blobs launching from a red giant star 1,200 light years away, called V Hydrae. The plasma is 17,000 degrees Fahrenheit and spans 40 astronomical units—roughly the distance between the sun and Pluto. The blobs don't erupt continuously, but once every 8.5 years.

The launching pad of these blobs, the researchers propose, is a smaller, unseen star orbiting V Hydrae. The highly elliptical orbit brings the companion star through the outer layers of the red giant at closest approach. The companion's gravity pulls plasma from the red giant. The material settles into a disk as it spirals into the companion star, whose magnetic field channels the plasma out from its poles, hurling it into space. This happens once per orbit—every 8.5 years—at closest approach.

When the red giant exhausts its fuel, it will shrink and get very hot, producing ultraviolet radiation that will excite the shell of gas blown off from it in the past. This shell, with cavities carved in it by the cannon-balls that continue to be launched every 8.5 years, will thus become visible as a beautiful bipolar or multipolar planetary nebula.

The astronomers also discovered that the companion's disk appears to wobble, flinging the cannonballs in one direction during one orbit, and a slightly different one in the next. As a result, every other orbit, the flying blobs block starlight from the red giant, which explains why V Hydrae dims every 17 years.

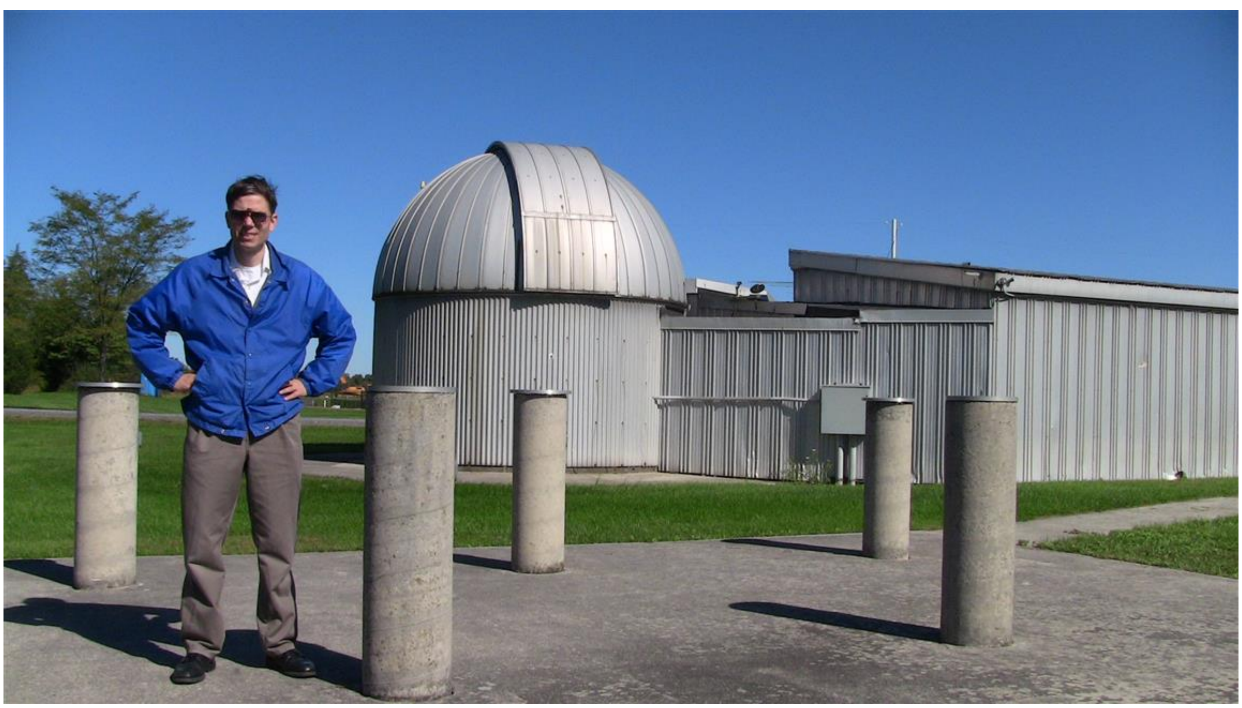
For decades, amateur astronomers have been monitoring this variability, making V Hydrae one of the most well-studied stars. Because the star fires plasma in the same few directions repeatedly, the blobs would create multiple lobes in the nebula—and a pretty sight for future astronomers. If you'd like to teach kids about how our sun compares to other stars, please visit the NASA Space Place: http://spaceplace.nasa.gov/sun-compare/en/



This four-panel graphic illustrates how the binary-star system V Hydrae is launching balls of plasma into space. Image credit: NASA/ESA/STScI

Oh, Snap!

The constellation Auriga to the left of the tree and Taurus the Bull on the right around 11 p.m at f2.8 over 16 seconds with asa 200 using a Kodak Easyshare camera. View near Gettysburg battlefields; photo by Dave Raker.



Dave stands near the observatory at Gettysburg College. The pedestals are used for attaching telescopes. The college has a newly renovated planetarium that doubles as a classroom. with a digital projector for the stars.

Oh, Snap! is a monthly feature of LVAAS members' astronomy and celestial works which have been generously shared for the enjoyment of our readers. Kindly submit your original photos, videos or other material to editorlvaas@gmail.com

"Let the stars in the sky

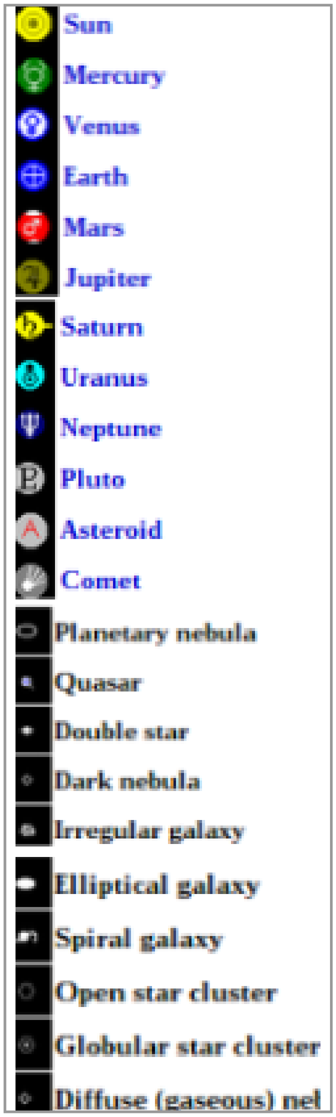
Remind us of mans' compassion

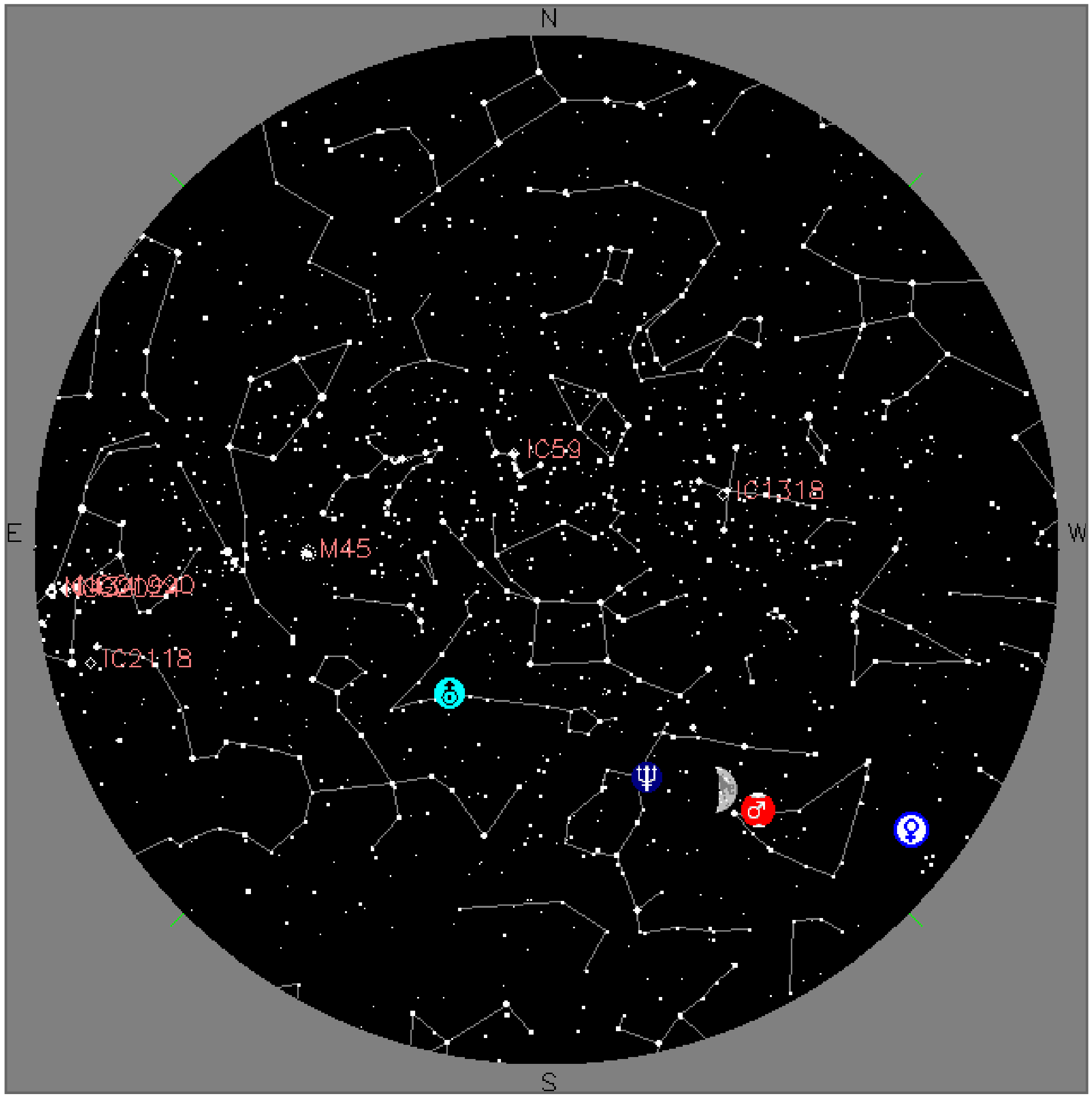
Let us love 'til we die

And God bless us, everyone"

Excerpt from "A Christmas Carol": The Musical
Music by Alan Menken
Lyrics by Lynn Ahrens
Based on the book by Charles Dickens
Link to the song performed by the original cast ensemble:
https://www.youtube.com/watch?v=-BgJ1tcG1rE

Sky above 40°33'58"N 75°26'5"W at Tues 2016 Dec 6 0:00 UTC





Your Sky was implemented by John Walker in January and February of 1998. The calculation and display software was adapted from Home Planet for Windows.

The GIF output file generation is based upon the ppmtogif module of Jef Poskanzer's pbmplus toolkit, of which many other components were used in creating the images you see here.

ppmtogif.c - read a portable pixmap and produce a GIF file

Based on GIFENCOD by David Rowley [mgardi@watdscu.waterloo.edu].

Lempel-Zim compression based on "compress".

Modified by Marcel Wijkstra [wijkstra@fwi.uva.nl]

*Check out additional features of **Your Sky** at :* http://www.fourmilab.ch/yoursky/

Please visit lvaas.org for up-to-the-minute calendar information

DECEMBER 2016

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				01	02	03 Star Party
04	05	06	07 First Quarter Moon	08 LVAAS Scout Group - South Mountain	09	10 General Meeting/Holiday Party 2:00 PM
11	12	13 Full Moon	14	15 Astro Imaging	16	17
18 LVAAS Board of Governors Meeting	19	20 Last Quarter Moon	21	22	23	24
25	26	27	28	29 New Moon	30	31

JANUARY 2017

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
01	02	03	04	05 First Quarter Moon	06	07
08 General Meeting - 2:00 PM Muhlenberg	09	10	11	12 Full Moon Astro Imaging 7:00 PM	13	14
15	16	17	18	19 Last Quarter Moon	20	21
22	23	24	25	26	27 New Moon	28
29 LVAAS Board of Governors Meeting	30	31				

2016 LVAAS Event Calendar

2016 LVAAS Event Calendar												
	Sundays			Thursday	Saturdays		Mondays	Multi-Day Weekends	Moon Phase			
	General Meeting	Board meeting		Astro-Imaging		Star Parties	Scouts at S. Mountain	Scouts at Pulpit R.	New	First	Full	Last
January	2:00 PM 10-m	31		21		no mtg		no camping	9	16	23	2 31
February	2:00 PM 14-m	28		25		13		no camping	8	15	22	
March	13	20		24		19		no camping	8	15	23	1 31
April	10	24		21		16		22-24	7	14	22	29
May	15	22		19		14		20-22	6	13	21	29
June	12	26		no mtg		11		24-26	4	12	20	27
July	05:00 PM 9-s	31		no mtg		16		15-17	4	11	19	26
August	13-sp	28		no mtg		6		19-21	2	10	18	24
September	11	25		15		10		16-18	1 30	9	16	23
October	9	30		13		8		14-16	30	9	16	22
November	2:00 PM 13	27		17		5		11-13	29	7	14	21
December	2:00 PM 10-sc	18		15		3		no camping	29	7	13	20

(-s) = Saturday meetings - Rain date on Sunday
(-m) = Muhlenburg College
(-sp) = Saturday meeting at Pulpit Rock
(-sc) = Saturday Holiday Party at Grace Community Church
All meetings 7:00 PM unless noted otherwise

Contributed by Bill Dahlenburg

2017 LVAAS Event Calendar

2017 LVAAS Event Calendar													
	Sundays			Thursday	Friday	Saturday	Mondays	Multi-Day Weekends	Moon Phase			
	General Meeting time	location	Board meeting	Astro-Imaging	Lunatics and Stargazers	Star Parties	Scouts at S. Mountain	Scouts at Pulpit R.	New	First	Full	Last
January	2:00 PM 8	Muhlenberg	29	12	no mtg	no mtg		no camping	27	5	12	19
February	2:00 PM 12	Muhlenberg	26	9	no mtg	no mtg		no camping	26	3	10	18
March	2:00 PM 12	Muhlenberg	26	9	3 & 31	4		no camping	27	5	12	20
April	9	S.M.	30	13	no mtg	1		7 – 9	26	3	11	19
May	7	S.M.	21	11	5	6		19 – 21	25	2	10	18
June	11	S.M.	25	no mtg	2	3		9 – 11	23	1 30	9	17
July	05:00 PM 8	S.M.	30	no mtg	28	29		14 – 16	23	30	9	16
August	12	Pulpit	27	no mtg	25	26		4 – 6	21	29	7	14
September	10	S.M.	24	7	29	30		8 – 10	20	27	6	13
October	8	S.M.	29	5	27	28		6 – 8	19	27	5	12
November	2:00 PM 12	S.M.	26	2	no mtg	25		3 – 5	18	26	4	10
December	2:00 PM 9	Grace Community	17	7	no mtg	no mtg		no camping	18	26	3	10

MegaMeet May 26th to 28th

July, Aug & Dec are Saturday meetings with rain date on Sunday
Jan., Feb., and March meetings are at Muhlenberg College
August meeting is at Pulpit Rock
December meeting / Holiday Party is at at Grace Community Church

Contributed by Bill Dahlenburg

Publishing images is a balancing act!

When preparing your images for publication in The Observer, please consider the following guidelines:

Put the quality in:

- Considering the "print" size of the image, make sure you have at least 150 pixels/inch.
- Use a reasonably good quality for the JPEG compression ratio.

But watch the "waistline"!

- Don't go too much above 200 pixels/inch max.
- Use the lowest JPEG quality that still looks good!
- Shoot for <300KB for a 1/2 page image or <600KB for a full page.

Tip: If you're not Photoshop-savvy, you can re-size and compress undemanding images ("human interest", not astro-images), with an online tool such as http://www.ivertech.com/freeOnlineImageResizer/freeOnlineImageResizer.aspx. It will also tell you the pixel size and file size of your original, even if you don't download the processed copy.

The Observer is the official monthly publication of the Lehigh Valley Amateur Astronomical Society (LVAAS) Inc., 620-B East Rock Road, Allentown, PA, 18103 and as of June 2016, is available for public viewing. Frances A. Kopy, editorlvaas@gmail.com

Members please use above email address for submissions.

Society members who would like to submit an article or image for publication should kindly do so by the Sunday before the monthly meeting of the BOG (please see calendar on website) for the article to appear in the upcoming month's issue. PDF format is preferred. Early submission are greatly appreciated. Articles may be edited for publication. Your comments and suggestions are invited.

Every effort is made to properly credit the sources of the material used in this publication. If additional credit is required, please notify editorlvaas@gmail.com with the required information for a timely correction.

To update LVAAS information or to make member contact changes or corrections, please email LVAAS Director Rich Hogg, theotherplanb@gmail.com or Assistant Director Sandy Mesics astrosandy@gmail.com.