NIGHTFALL

A Publication of the Huachuca Astronomy Club

Galactic Distancing Edition

June 2020

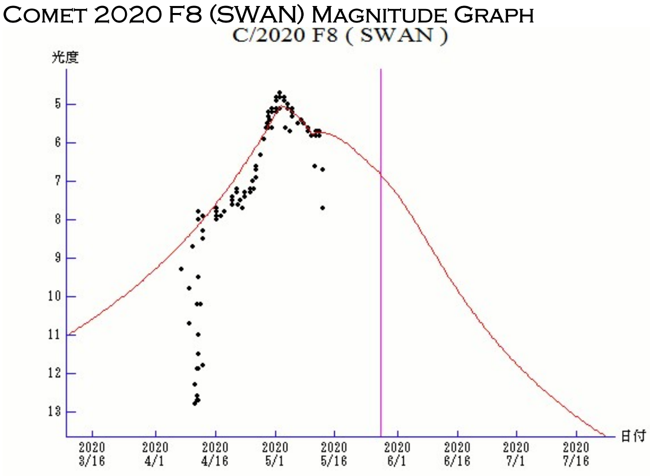
President's Notes

Well, well, well, we have made it to… hold on a second… let me find the calendar… carry the one… it's… June 2020. I hope everyone is still well, physically and mentally, after this extended live-at-home period. to keep busy I've turned over the dust in my observatory several times, although I don't think anything has changed in the overall scheme of things, but the positions of accumulated matter has, relativistically speaking.

The club has settled into some interesting discussions on the group mail list including some way-back time-warp topics, such as double star observations and real cosmological science news events. The HAC board has begun talking about resuming our meetings, virtually, using Zoom (or zoom-like) conferencing. While this is in no way the same as our in-person meetings, for the foreseeable future they might just fill the bill. We'll keep you informed as to our progress.

Speaking of cosmological events, we have a possible naked-eye comet C/2020 F8 (SWAN) in the early morning sky during the first couple of weeks in June. Then it will dim pretty quickly. Below is a chart showing the recorded magnitudes (black dots) and the anticipated magnitudes (red line).

Comet 2020 F8 (SWAN) Magnitude Graph



Source: Copyright(C) Seiichi Yoshida (comet@aerith.net) May2020

Just as a reminder: Jupiter and Saturn are nearing opposition, so it is time to linger on them while they are at their best. Mars and Neptune grace the late-night to early morning sky, with Mars looking larger all the time. While we are getting ready to view, draw and image Mars later this summer. Try to get the needed eyepiece practice now by examining Jupiter and Saturn every chance you get. For Saturn, see if you can determine the major ring gaps. For Jupiter, see if you can make out barges and festoons in the bands. Look not for the obvious features but for the most subtle differences you can tease out during your viewing sessions.

Nancy and I have been asked several times to give a tour of the upper RISS observatory, and this month I have no excuse not to do so. RISS version 3, is my "home class" roll-off observatory. It is not built for large gatherings. In fact, two (eh, maybe three) people pack it beyond the social distancing guidelines, but it is very useful as a personal observatory.

Located on our home's rear deck, it is about a half-story above grade. High enough to get away from surface temps and many of our local critters. As I've said before, it is small for a Cochise County observatory, measuring roughly 16 feet east west and only 8 feet north south. The roof and half of the walls roll north towards the house and past the north wall to expose the sky, including just beyond the celestial pole. The roof rolls off and on by hand (a modified metal portable garage roof system, with roller skate jelly wheels on a garage door track) and is amazingly easy to do one handed. The north wall is full height while the south wall folds down to expose the southern sky.

Move on, nothing to see here

Source: Small point and shoot Sony

From the outside, RISS is, I hope, invisible. Just a metal building at the back of the house painted to blend in with the rest of the house. My plan was to have it look like an RV garage to anyone giving it a quick glance. Inside the observatory I've tried to keep it spartan: two piers, two Dell micro footprint computers, two mounts with two clumps of telescopes, two chairs, and a rolling toolbox. The toolbox has been repurposed many times. Its latest incarnation is as a mobile solar rig station (nestled between the two piers). I've reduced and confined all wiring in the observatory to the piers, although this fought me at every turn. Now, only AC power is fed to the piers and microcomputers; everything else is wireless.

Comfy for two but not built for crowds

Source: Small point and shoot Sony

There is an exposed deck that runs another 12 feet from the north of the observatory's north wall to our 2nd story loft's south wall that gets covered when the observatory roof is rolled off. Inside the loft is where RISS continues as a control room and equipment depot. This adds another 100 or so square feet plus shelving to RISS and makes the whole observatory workable. I communicate with the mounts, scopes, and cameras using our wi-fi network. If I am looking through an eyepiece at the Meade 14 I can either slew around using the mount's hand controller or go inside for a second to my laptop's planetarium program (connected via TeamViewer to the microcomputer on the scope) to find and slew to what I'd like to look at. If I need to work out in the observatory, I can take the laptop out to the scope.

I do a lot of viewing through an eyepiece, but increasingly I use CMOS cameras as my eyepieces. The color, clarity, sensitivity, resolution, and reach of these cameras stretch well beyond what I can see with my telescopes using my un-enhanced eyes. Mere fuzzy patches and wobbly blobs of gray tones become colorful comets and barred galaxies. No, I'm not talking about astro-imaging so much as enhanced viewing or EAA astronomy (Electronically Assisted Astronomy) as it has become known. I use my rigs as near real-time viewers. Just like a zoom eyepiece I can increase a telescopes magnification by zooming in on the image, and just like moving to a much bigger telescope I can increase the camera's gain and/or exposure time to brighten and peer deeper into the night. I think of the images I take more as sketches or drawings of what I've been looking at, rather than fine-tuned astro-images (at which many in our club have become so accomplished).

Control desk, one laptop for each pier plus dual Monitors for each laptop (cheap TVs)

Source: Small point and shoot Sony

This third version of RISS observatory, the RISS-EAA observatory (newly christened) has been working wonderfully more than four years now. Oh sure, I change telescopes, fiddle with this or that, try to improve, modify, tweak; but really the shell has remained unchanged. Do I think about building another observatory? Heck yeah, but don't get me started. Ok I'll give you one clue, Steampunk.

Observatories are amazing critters. They can be designed with the only thought of just someplace to hold all your stuff or only to hold the spectrohelioscope you've worked ten years to build. They can be as simple as scraping three X marks in your concrete sidewalk or rolling a scope out of a garage on a buggy or pouring a concrete pier in your backyard. It is also now possible for you to build a fully robotic, completely AI driven masterpiece of technology that makes even you, its creator, request entry.

There is no end to the ingenuity of amateur astronomers nor the possibilities to build observatories given modern building materials. The aim of them all, fundamentally, is to make it easier for us to explore what is out there or is it what is there. We have more than fifty amateur and private observatories in Cochise County. You all have an open invitation to tell us about your observatory(s), or your ideas for an observatory, or about an observatory that you have visited that moved you. You needn't be confined to the visual spectrum either nor limited by scale or location. You don't even have to tell us where it is or what the outside looks like if you don't want to.

Until next time get out there and stare.

Welcome our New Members

Scott Voigt of Sierra Vista joined the club in April. Joining at the end of May was Matt Lieber and family (Stacey, Brin, Jack & Hannah). The Lieber's are buying ENDOR (Eagle's Nest

Digital Observatory) that was previously operated by Dennis and Jean Whitmer. Welcome, we are glad you joined!

Event hiatus continues

Looks like HAC's stand down due to the COVID-19 situation will continue through June and it will probably be after monsoon before we resume any outreach activities.

Cochise College cancelled our room reservations for June and July, so it's likely that any meetings held between now and August will be digital. The August meeting has been moved to the Library due to the unavailability of the Community Room which is being used for Student Services until further notice.

Student related events like the Patterson filed trips will not pick up again until the schools are back on a normal schedule. Patterson public nights, which are not scheduled during the monsoon months anyway, will pick up again in September (assuming the Corona virus danger has passed).

Meanwhile, our members continue to enjoy our hobby in isolation and activity on the Groups io list HacAstro has helped to keep club members in touch. There have been some interesting discussions and a good number of astro-photos posted on the group – evidence of a lot of observing activity going on. If you are not a member of the group, now is probably an excellent time to join (just send an email to HACAstro+subscribe@groups.io to get started. If you are already a member of the group – don't be shy about posting your observing reports or astro-imager

One Small Patch of Sky

Alex Woronow, 2020 #2

After processing an image to the best of my ability, I turn to searching for published information about the target object. Reading the Wikipedia entry often sets the stage by quickly summarizing 'what,' 'where,' and 'when.' But more importantly, Wikipedia sometimes offers a 'why'…why the object has scientific interest, when it does. Assuming it does, I hunt down peer-reviewed articles on the subject, or at least their abstracts, and compare those studies with what appears in my images—just to see how well I did. For M 83, something special happened. Unusual features I captured had not been described or discussed by professional astronomers or anyone else, as far as I can discover: an opportunity for me to describe and speculate—what fun!

Messier 83 (Southern Pinwheel Galaxy)

The "Grand Design" spiral galaxy, Messier 83 (Fig 1), has well-defined spiral arms showing simple structures, just as an archetypical Grand Design galaxy should. However, I have found that M 83 sports several abnormalities that the simplifying tag "Grand Design Galaxy" might not suggest. Referring to the numbers on the image in Fig 2, the newly discovered, unusual features/structures visible in this image include:

1. A hazy, Bright Halo, with smeared spiral-arm structure, surrounds, and is continuous with, the main galaxy. This halo is not entirely symmetrical, appearing wider at the right side of the galaxy (near the number "2" in Fig 2) and narrower on the left side.

2. A Dark Halo encircles the Bright Halo and wraps the entire galaxy. (This halo can be difficult to see. Move back from this image, relax your vision, and the dark halo becomes more clearly apparent.) A true image of M 83, which better shows all the features, is here: https://tinyurl.com/M83jpg100)

3. Beyond the Dark Halo, a faint bright arc appears from around 7 to 9 o'clock (Fig 2). It presents as if it were a portion of a spiral arm decoupled from the main galactic pinwheel.

4. Still farther out, spanning from about 6 to 8 o'clock (Fig 2) lies another smear of brightness, again mimicking a disarticulated spiral arm. It may join feature 3 at around 8 o'clock.

5. This feature covers the rest of the image; the background has luminosity above that expected for empty space.

For you to accept the validity of the image and the features listed above you should know some facts about the processing of the image in Fig 1 (and available at the link cited above). Fig 1's caption gives a few of the standard facts, but the processing methods most critically dictate what it reveals or doesn't. So …

• No mask, other than a simple star mask, was employed.

• No free-hand or other painting for enhancement or other reason was applied.

• All images were drizzled within PixInsight onto a 2x grid with a 0.8 droplet size.

• The luminosity channel was augmented by the RGB channels according to the equation L'=L+(R+G+B)/3. (L' is often referred to as a "Super Luminosity or "Super_L".") Features 1, 2, 4 and clearly appear in the unprocessed Super_L image, without much squinting, if you know where to look. Feature 3 is more difficult to see, but histogram stretching alone makes it visible.

• The Ha data were incorporated into the R channel according to the method described by Woronow1. Ha was not separately blended with the L channel because the R channel already has the correct intensity of Ha in it.

• The Topaz programs (Denoise and Studio2) employ artificial intelligence algorithms as does Luminar4 by Skylum. These programs were, obviously, used in the image processing.

No painting of any kind, no elaborate or unusual PixelMath altered this image...no jiggery-pokery— period! In the end, however, this seems to be a virtually unique image. I could not find a single professional image showing all, or even most, of the five features listed above. A survey of the archives of AstroBin, assessing the M 83 “Top Pick” and “Image of the Day” selections, uncovered these statistics: Of 47 images; 14 had none of the listed features, 24 had indications of the Bright Halo; 1 showed a vague indication of the Dark Halo; 2 showed indications of features 3 and 4 (the possible detached spiral arms) and 1 image showed a hint of a bright background sky in the vicinity of the galaxy. (There is some significant fuzzy judgement involved, of course, in assessing the presence/absence of these faint-fuzzy things.)

My take-away is that the image in Fig 1 is nearly unique in its revelation of the unusual features in and around M 83. Those features became apparent largely due to the emerging technology of image processing using artificial-intelligence algorithms. The biggest uplift came from Topaz Denoise AI.

OTA: TAO 150 (f/7.3) Camera: FLI - ML16200 (1.13”/pixel)
Observatory: Deep Sky West, Chile
EXPOSURES: Red: 10 x 600”, Blue: 12 x 600, Green: 12 x 600, Lum: 12 x 600, Ha: 12 x 1800
Image Width: ~1 deg
Processed by Alex Woronow (2020) using PixInsight, Skylum, Topaz, SWT
The only mask used in processing this image was a star mask

Fig 1.The Messier 83 image showing the features described in the text and labeled in Fig 2. A better quality version can be accessed at https://tinyurl.com/M83jpg100.

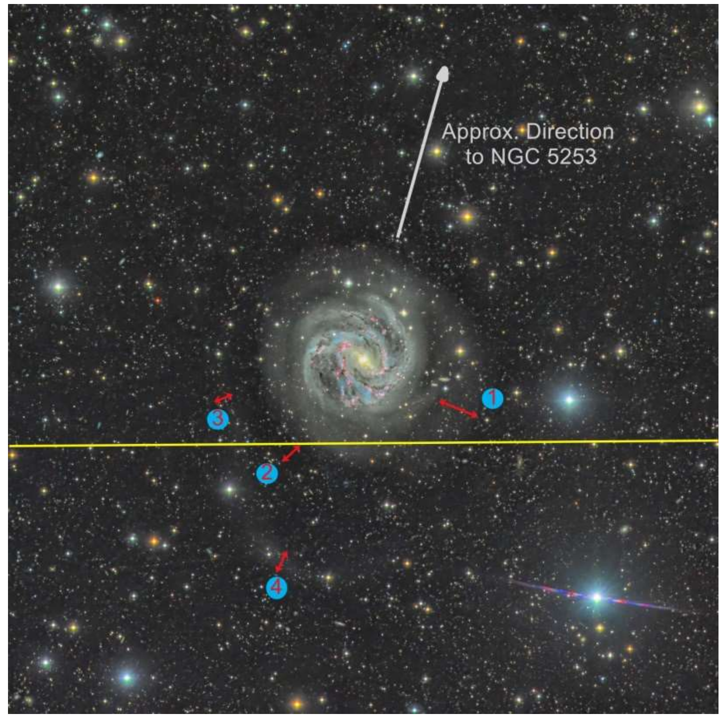


Fig 2. Features 1 to 4 discussed in the text. The red arrows span the inner-to-outer extent of the features. Feature 5 is not labeled but occupies the entirety of the background of the image (and beyond?). The yellow line approximately locates the brightness profile shown in Fig 3.

Additional Observations about each Feature

Working from Feature 1, proximal to the spiral arms, outward, some of the important attributes of each feature will be described. A discussion of the compositions and origins of the features will follow. Viewing the image at https://tinyurl.com/M83jpg100 will be helpful here (and throughout the rest of the discussions).

1. The Bright Halo: Almost featureless and presenting an obvious bulge toward the right-bottom of the image (Fig 1). It displays some smeared dark structures toward its inner edge and its brightness tapers down outward from the galaxy. Its outer edge is better defined than its inner edge, abutting against the Dark Halo, 2 in many places. The Bright Halo encloses the entire circumference of the Grand Design part of M 83.

2. The Dark Halo: its inner edge contacts the Bright Halo and it encircles the entire galaxy. This edge is relatively easily delineated. Its outer edge is most distinct at the left, where it abuts Feature 3, and least distinct towards its lower right, where the bulge in the Bright Halo occurs. It appears, vaguely, also to bulge toward the lower right and bottom of the image, although the outer edge is indistinct in this region.

3. This quite faint bright-arc bounds the Dark Halo at the left to lower left in Figs 1 and 3. Its extent toward the top of the image becomes difficult to trace as three bright stars may lead one to imagine it extends farther than it does.

4. This streak, brighter than Feature 3, but fainter than the Bright Halo, by-and-large, lies a considerable distance outside the main galaxy. It is arcuate in shape, and may trace inward and connect with Feature 3 at about 7:00. Again a bright star interferes with the ability to trace the upper part of the feature. At about 5:00 a faint smudge appears to pinch the Dark Halo against the bulge of the Bright Halo. This smudge may be the clockwise extension of Feature 4.

5. The rest of the background of this image (and undoubtedly to some extent beyond) is brighter than deep space generally is. A patchy haziness can be sensed over the entire area with occasionally hazy, ill-defined patches of clouds pervading the area. The background is clearly brighter than the Dark Halo; otherwise, the Dark Halo would not be distinguishable against it.

Classically, galaxies have none of the features or structures just described. But, then, as far as was known until now, neither did M 83. Amateurs may have something to contribute to science by surveying more face-on galaxies with image fields that extend beyond the galaxy's arms and deeper processing using AI to suppress noise and enhance structures and contrasts.

The Setting of M 83

M 83 is a member of "M83 Group" of galaxies and in close proximity to the Centaurus A group. The known members of the M83 Group total 15—mostly dwarf galaxies. The nearest galaxy to M 83 is NGC 5253, a "blue dwarf" galaxy. The current distance between these two galaxies is only 1.6 + 1.32 Mly. M 83 and NGC 5253 are thought to have had significant gravitational interactions within the last billion years, which set-off star-burst activity in both, and most likely precipitated the formation of the features being discussed.

Speculations on the Bright-Halo's Origin

Plausibly, the Bright Halo arose from the effects of gravitational pull by NGC 5253. A spectrographic study2 suggests that ionized gas occurs abundantly in a layer above the galactic plane of M 83. But that study did not tie the observed gas layer to the Bright Halo described here. However the study validates the general concept that something, probably a gravitational interaction has disrupted the normal distribution of mass found in a spiral galaxy.

Naturally, gravitational effects from a companion galaxy would be greater on the outer reaches of the spiral arms than they would be closer to M 83's center. This might generate disorder in the outer spiral arms, smearing them into the nearly featureless halo we observe as Feature 1. This smeared halo is not entirely featureless, as noted before, and some darker features may be what remains to delineate the now-smeared spiral arms.

If M 83's rotation period were similar to the Milky Way's, a few hundred-million years, then the gravitational smearing may have interacted strongly around the entire galaxy as M 83 rotated and NGC 5253 passed by. The asymmetry, the bulge, in the Bright Halo could have arisen at the time when the two galaxies were at their nearest approach. Subsequently, the bulge would rotate from its initial azimuth to its current location, as rotation of M 83 carries it along.

Speculations on the Origin of Features 3 and 4

Features 3 and 4 may be just as they appear: distorted and displaced spiral arms caused by the gravitational interaction with NGC 5253.The outward displacement of the inner-most feature, Feature 3, may not place it at an unusual distance for a spiral-galaxy arm, but Feature 4 probably lies abnormally distant from the core galaxy. (I am not aware of any studies that substantiate this speculation, however.) Also perplexing, the extreme smearing of the bright halo seems at odds with a reasonably coherent nature of Features 3 and 4. But, perhaps most enigmatic is that these two features lie beyond the Dark Halo, and appear detached from the galaxy proper. Perhaps these enigmas point to these features not being detached spiral arms but something else?

Origin of the Dark Halo

Tautologically, the Dark Halo appears darker than the surrounding background sky. Bearing in mind that the stars we see are in the foreground, within the Milky Way, and not in the background sky, two alternative scenarios might explain the Dark Halo - background relationship:

1. A plethora of dark clouds comprises the Dark Halo and hides the background sky behind it, which, at least locally, is brighter than the Dark Halo.

2. The Dark Halo simply lacks the bright elements present in the background sky, with some minor exceptions, perhaps.

Let us first establish that patchy, faintly bright clouds pervade the background, 5, of this image and that they do lie beyond our Milky Way. The evidence for these assertions is simple: The existence of the Dark Halo, being darker than the rest of the sky, implies that the rest of the sky is not as dark as it could be. Furthermore, the bright component of the background sky lies beyond the Milky Way or it would cover the Dark Halo as it does the rest of the image. Fig 3 shows a brightness transect across the image (see Fig 2 for the transect location). Note that toward the left side of Fig 3, the darkest dabs of the background sky (in this transect, anyway) are not as dark as the darkest dabs in the Dark Halo. How far beyond the limits of the imaged area this elevated background sky-brightness extends remains unknown.

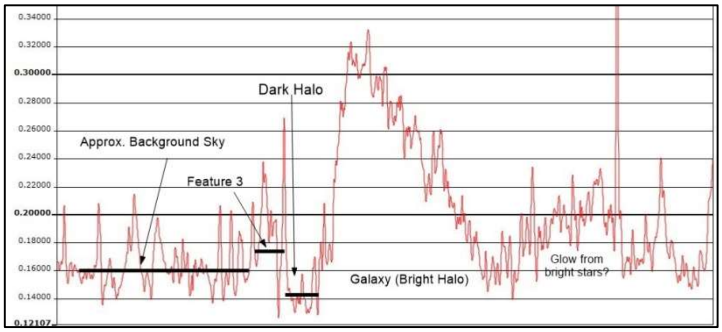


Fig 3. A brightness profile horizontally across the image in Fig 2. The source image had suppressed star intensities and was smoothed using a Gaussian blur, both to suppress noise in the graph.

As to how the Dark Halo arose, I can postulate two alternatives:

A. The Dark Halo consists of gas and dust bled from the Bright Halo by some form of gravitational sorting that left the stars behind. The dust and gas formed into clouds: dark clouds because no stars were drawn into the zone of Feature 2.

B. The Dark Halo is dark because bright background clouds covering the rest of the image either never formed there or were once there but were swept from the Dark Halo as Features 3 and 4 (and others) moved outward, under the influence of gravitational attraction by NGC 5253, and took the stars, dust and gas with them. Thus, the Dark Halo is dark simply because it does not have the components generating the lightness prevailing across the local background.

Origin of the Background Brightness

The brightness of the background must arise from gas, dust, and the stars to illuminate them. These may be remnants from a disrupted dwarf galaxy (or more than one) consumed by M 83 or chunks torn from M83 and/or NGC 5352 in their close encounter. Most likely, deep, broad-field images will reveal that this feature forms another halo around M 83.

Conclusions

Gravitational interactions between M 83 and NGC 5253 have sculpted significant large-scale structures in M 83. The existence of these structures does not appear to have been reported previously, although some amateur images show, or hint at, their existence.

The inner-most feature or structure, the "Bright Halo", lies just exterior to the structurally defined spiral-arms of the galaxy. This inner-most feature is bright with some vague residual spiral-arm structures. It is not perfectly round, but exhibits a bulge that could be a tidal bulge.

A Dark Halo fully encloses the Bright Halo and is darker than the surrounding sky. This region probably owes its darkness to clouds of gas and dust and a dearth of stars to illuminate them. These clouds prevail in the Dark Halo, but do not uniformly or completely cover it; some brighter patches occur. The gasses that accumulated into this halo may have escaped from the more central regions of M 83, or from the Bright Halo itself, under the gravitational influence of NGC 5352.

Exterior to the Dark Halo lie two elongate clouds, noticeably arcuate in shape. They cover only a limited proportion of the circumference of the galaxy, and have the rough appearance of galactic spiral arms. If and where they may join with the main galaxy or with the Bright Halo is unresolved in this image. If they do not connect, then they may have 'escaped' tight association with M 83 with the assistance of the antipodal or direct gravitational attraction of NGC 5352.

Dust, gas and stars scatter around the background of this M 83 image. Perhaps they recall the consumption of one or more dwarf galaxies by M 83, or they are debris dragged from M 83 and NGC 5352 during their last close encounter. I suspect they form a faint, extended halo around M 83.

Things it would be nice to know:

- The rotational-velocity profile of M 83 and its associated features
- The path of NGC 5253 relative to M83 over the last billion years or so
- The extent of the faint bright background (halo?) in the broader vicinity of M 83
- The physical state and composition of the Dark Halo
- The components (stars and/or gas?) of objects 3 and 4.

Coda

This article contains a great amount of speculation. But without ready access to professional journals, an impressive professional telescope with spectrographic equipment, and a research grant to run it, that's about what this small-town amateur can do. In any case, it has been great fun and greatly satisfying to identify and ponder the characteristics of this deep-sky object and to be able to ponder the origins of M 83's strange features. If you have images, information, or ideas, I would certainly like to hear about them.

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1. Woronow, A. (2017) Blending Ha with Red…a New Approach. https://tinyurl.com/yckx9jyw
2. Thim, F, et al. (2003) https://tinyurl.com/thim2003
3. Bottcher, E, et al. (1218)
https://arxiv.org/pdf/1707.08126.pdf

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NASA Night Sky Notes June 2020

This article is distributed by NASA Night Sky Network

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Summer Triangle Corner: Vega

By David Prosper and Vivian White

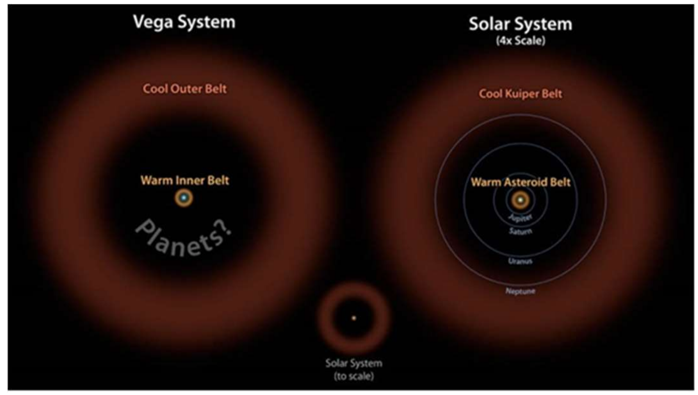
If you live in the Northern Hemisphere and look up during June evenings, you'll see the brilliant star Vega shining overhead. Did you know that Vega is one of the most studied stars in our skies? As one of the brightest summer stars, Vega has fascinated astronomers for thousands of years.

Vega is the brightest star in the small Greek constellation of Lyra, the harp. It's also one of the three points of the large "Summer Triangle" asterism, making Vega one of the easiest stars to find for novice stargazers. Ancient humans from 14,000 years ago likely knew Vega for another reason: it was the Earth's northern pole star! Compare Vega's current position with that of the current north star, Polaris, and you can see how much the Earth's tilt changes over thousands of years. This slow movement is called precession, and in 12,000 years Vega will return to the northern pole star position.

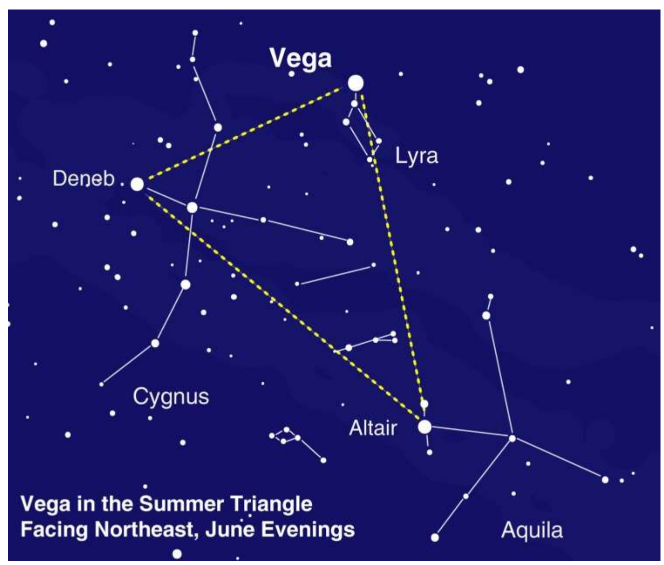
Bright Vega has been observed closely since the beginning of modern astronomy and even helped to set the standard for the current magnitude scale used to categorize the brightness of stars. Polaris and Vega have something else in common, besides being once and future pole stars: their brightness varies over time, making them variable stars. Variable stars' light can change for many different reasons. Dust, smaller stars, or even planets may block the light we see from the star. Or the star itself might be unstable with active sunspots, expansions, or eruptions changing its brightness. Most stars are so far away that we only record the change in light, and can't see their surface.

NASA's TESS satellite has ultra-sensitive light sensors primed to look for the tiny dimming of starlight caused by transits of extrasolar planets. Their sensitivity also allowed TESS to observe much smaller pulsations in a certain type of variable star's light than previously observed. These observations of Delta Scuti variable stars will help astronomers model their complex interiors and make sense of their distinct, seemingly chaotic, pulsations. This is a major contribution towards the field of astroseismology: the study of stellar interiors via observations of how sound waves "sing" as they travel through stars. The findings may help settle the debate over what kind of variable star Vega is. Find more details on this research, including a sonification demo that lets you "hear" the heartbeat of one of these stars, at: bit.ly/DeltaScutiTESS

Interested in learning more about variable stars? Want to observe their changing brightness? Check out the website for the American Association of Variable Star Observers (AAVSO) at aavso.org. You can also find the latest news about Vega and other fascinating stars at nasa.gov.



Vega possesses two debris fields, similar to our own solar system's asteroid and Kuiper belts. Astronomers continue to hunt for planets orbiting Vega, but as of May 2020 none have been confirmed. More info: bit.ly/VegaSystem Credit: NASA/JPL-Caltech

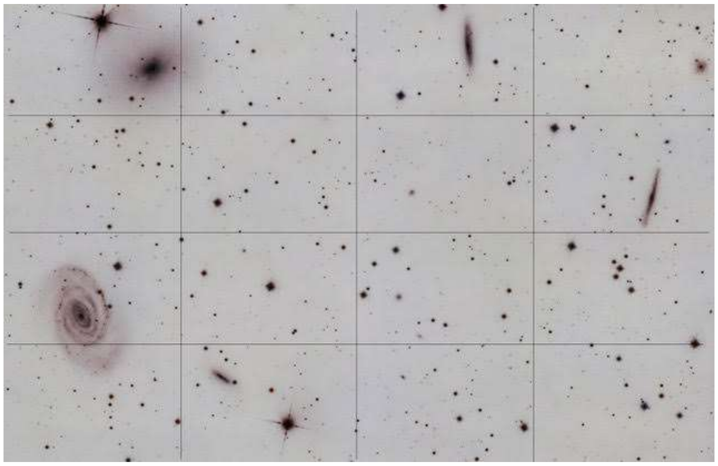


Can you spot Vega? You may need to look straight up to find it, especially if observing after midnight.

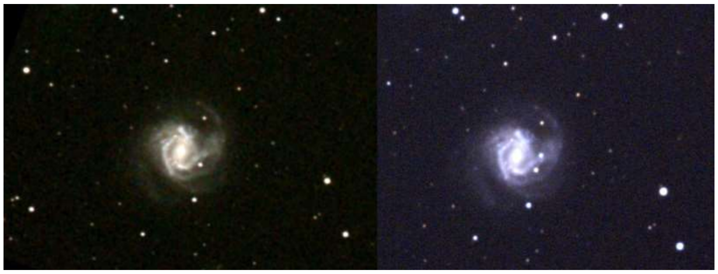
Pictures from HAC Members

NGC 5653/5654 by Glen Sanner

NGC 5653/5654 Inverted by Glen Sanner



M61 before and after supernova by David Roemer



Comet Swan by Jay LaBlanc

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HAC Jun/Jul Calendar of Events

SU	MO	TU	WE	TH	FR	SA
31 **JUNE EVENTS ARE TENTATIVE**	**Jun 1** **TBD BY THE STATUS OF CONTINUING SITUATION**	**2**	**3**	**4** Mercury at greatest eastern Elongation	**5** **12:12 pm** **HAC Meeting**	**6**
7	**8** Jupiter-Saturn and Moon in morning sky	**9**	**10**	**11**	**12** **11:24 pm**	**13**
14 	**15**	**16**	**17**	**18**	**19**	**20** **11:41 pm** Summer Solstice 2:44 PM
21 	**22**	**23**	**24**	**25** **Patterson Public Night 8 PM (?)**	**26**	**27**
28 **1:16 am**	**29**	**30**	**1 Jul** **JULY EVENTS ARE TENTATIVE**	**2** **TBD BY THE STATUS OF CONTINUING SITUATION**	**3**	**4** 
5 **9:44 PM** **on the Fourth Penumbral lunar eclipse**	**6** Saturn and moon 2 degrees	**7**	**8**	**9**	**10** Hac Meeting Venus at greatest brillancy	**11**
12 **4:29 PM** Pallas Opposition	**13**	**14** Jupiter Opposition	**15** Pluto Opposition	**16**	**17** Venus and moon 3 degrees	**18** Mercury and moon 4 degrees
19	**20** **10.33 am** Saturn Opposition	**21**	**22** Mercury at greatest western elongation	**23**	**24**	**25**
26	**27** **5:33 am**	**28** Delta Aquariid meteors	**29** Delta Aquariid meteors	**30** Delta Aquariid meteors	**31**	

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