

# The High Desert Observer

## October 2016



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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.*

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### ASLC Board of Directors, 2016

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Night Sky Network: **\*\*\*OPEN\*\*\***

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Outreach: Chuck Sterling; [csterlin@zianet.com](mailto:csterlin@zianet.com)

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### October Meeting --

Our next meeting will be on **Friday, October 28**, at the Good Samaritan Society, Activities Room, starting at 7:00 p.m.

The speaker will be Bill Godby, Range Archeologist at White Sands Missile Range (WSMR)

Topic: Clyde Tombaugh designed and built telescopes at WSMR.

### Member Info Changes

All members need to keep the Society informed of changes to their basic information, such as name, address, phone number, or email address. Please contact [Treasurer@aslc-nm.org](mailto:Treasurer@aslc-nm.org) and [jkile3916@gmail.com](mailto:jkile3916@gmail.com) with any updates.

### 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 constellations in the sky.

### 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.

## **Outreach Events For September 2016**

by Jerry McMahan

### ***Tombaugh Observatory, Friday, September 9***

Clouds and rain. Sorry, force of habit. Actually it was clear. There was enough haze to prevent a good view of Saturn, but the Moon gave us a good view.

Steve Shaffer came early to kill black widows. After a few months of no observations and wet weather, there were a lot of spiders. Rumor has it that the next villain in a Spiderman movie, will be based on Steve. Chuck Sterling also joined us. A few days later, Chuck donated a red light bulb for the observatory. It is on the top shelf, Steve.

### ***Moongaze, Saturday, September 10***

We had another clear night. Chuck Sterling set up his 10 inch and I had the 8 inch. Daniel Giron set up binoculars. We had some good views of the Moon and Saturn. Two clear nights in a row. Very unusual recently.

### ***Leasburg, Saturday, September 24***

The Curse of Leasburg ended, sort of anyway. It was clear, but we only had one telescope being used. Daniel Giron, Sid Webb and Bob Armstrong were in the observatory, but, once again, the 16 inch would not work again. It turned out to be a USB port problem, but the result was no observing in the observatory.

I attended, but due to chest congestion, I did not bring a telescope. Chuck Sterling was at Okie-Tex, so he was not available with the 10 inch. Ed Montes was also present, but no telescope. The only scope in use was the park's 12 inch Dobsonian, manned by Sid Webb. We had a lot of club members, but very little observing. Hopefully it is not the beginning of a new kind of the Curse of Leasburg.

### ***Leasburg, Saturday, October 1***

Daniel Giron opened the observatory as a special request. The 16 inch worked fine, and Chuck Sterling, back from Okie-Tex, set up his 10 inch. I intended to go, but more congestion problems prevented my attendance. As a result, I hope I am not leaving any one out. I was told that Ed Montes and Bob Armstrong were there. It was clear again and there were two scopes being used, one more the the previous event.

Daniel was going to try the observatory the previous night. I have not heard if the weather allowed observing, or how many people may have attended.

\* \* \*



**Meeting Minutes**  
by John McCullough

***Show & Tell:***

These session was devoted to examining telescopes that cannot be used for public outreach or in the Loaner Telescope program. The telescopes were offered to members on a “first come, first served” basis and any remaining telescopes would be offered to non-members that are present.

***Call to Order:***

Daniel Giron, President, Astronomical Society of Las Cruces (ASLC, the Society), called the September 2016 business meeting to order at 7:30 pm, 23 September 2016, Creative Arts Room, Good Samaritan Society Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, New Mexico.

***President’s Comments:***

Daniel Giron, President, welcomed the group to tonight’s meeting and directed attendees’ attention to the “giveaway” telescopes that are available tonight. He asked that all members be sure to check in on the roster and that visitors and guests sign the guest list. He asked if all members had received the latest edition of the Society’s newsletter, the High Desert Observer (HDO), had a chance to read the August meeting minutes and if there any were any comments, issues, or concerns. Noting none, Sid Webb moved and Chuck Sterling seconded that the August minutes as published in the HDO be approved. The August minutes were accepted by acclamation.

***Treasurer’s Report:***

The Treasurer, Trish Conley, was not present at tonight’s meeting. There was no Treasurer’s report.

***Committee Reports:***

***Outreach Committee:***

Chuck Sterling, Outreach Coordinator, reported there will be a “Music and Stars” event at Leasburg Dam State Park (LDSP) on 24 September, weather permitting, although there may not be a musical performance. Two or three observatory operators are needed for observing beginning at dusk. Okie Tex Star Party starts 24 September at Camp Billy Joe in the Oklahoma Panhandle. There will be a Tombaugh Observatory open house on 07 October on the NMSU campus. There will be a Moon Gaze at International Delights Café (IDC) on 08 October. Astronomy Day is also 08 October with a possible event at LDSP. A star party for home school students will be held 11 October at Veterans’ Park. Another “Music and Stars” event is planned for LDSP on 22 October.

***Tombaugh Observatory:***

Steve Shaffer, Committee Chairman, was not present, but an open house will be held 07 October (see above).

***2017 Officer Nominating Committee:***

Thanks to the efforts of the Nominating Committee of Chuck Sterling, Tracy Stuart, and Howard Brewington, a slate of candidates is offered:

President	Howard Brewington
Vice-President	Rich Richins
Treasurer	Trish Conley (incumbent)
Secretary	John McCullough (incumbent)
Director-at-Large #1	Ed Montes (incumbent)
Director-at-Large #2	Sid Webb (incumbent)



## ***Back at the Telescope***

by Bert Stevens

Remote sensing is a term that has come into existence in the last sixty years. The term is usually applied to spacecraft that have instrumentation to measure some physical quantity from a distance. The object being measured could be a planet (especially Earth), the Sun, or another Solar System member.

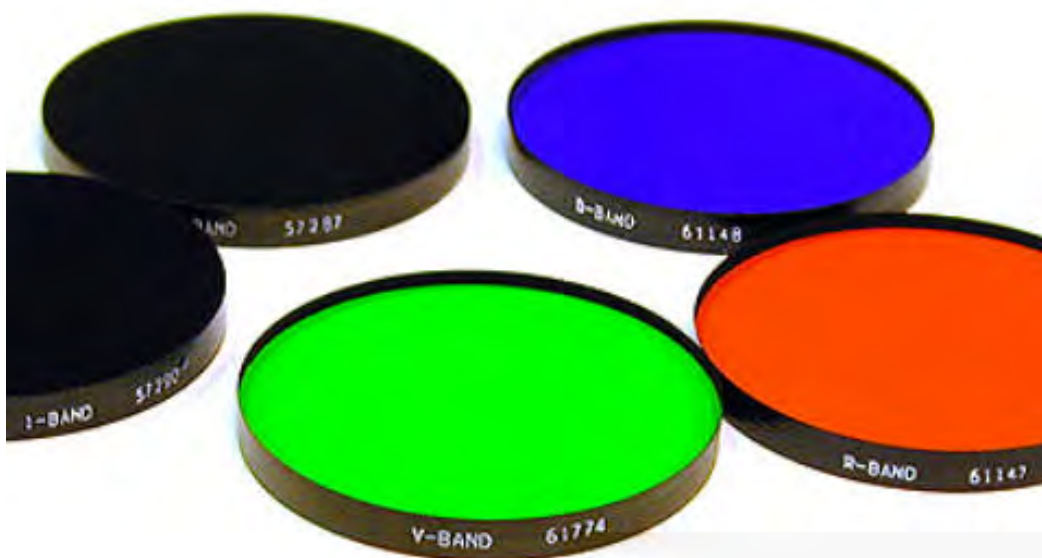
While thinking about remote sensing, I realized that astronomers have been remote sensing the universe since the dawn of recorded history. No one has ever stuck a thermometer into a star or sampled the gas in a nebula, but we know a great deal about them. With the great distance to these objects, it is unlikely that we will be able to get samples of the universe anytime soon.

Astronomical remote sensing starts with the selection of instruments at the focus of a telescope. The human eye is an excellent sensor, but there is no ability to make an impartial record of the observation. Drawings of the astronomical object are about the only way to record a planetary observation made with the eye. Variable star observers use the eye to make estimates of the brightness of a variable star by comparing it to neighboring stars of known brightness.

Instrumentation beyond the eye became possible with the invention of photography. This allowed permanent images of celestial objects to be made. Astronomers are able to look back at old images and see an object at an earlier time to see if there was any hint that a new feature was going to come into existence. Photography also allowed faint objects not visible to the naked eye to be recorded on plates with long exposure times that made them visible to us.

Electronics brought us new and more flexible sensors. The most basic instrumentation is the photoelectric photometer (PEP). This device made it possible to make a more accurate measurement of the amount of light entering the photometer's aperture than could be made by eye. The PEP also could make estimates of fainter objects by longer exposures, just like photographic plates.

The development of integrated circuits and semiconductor technology allowed the creation of a better

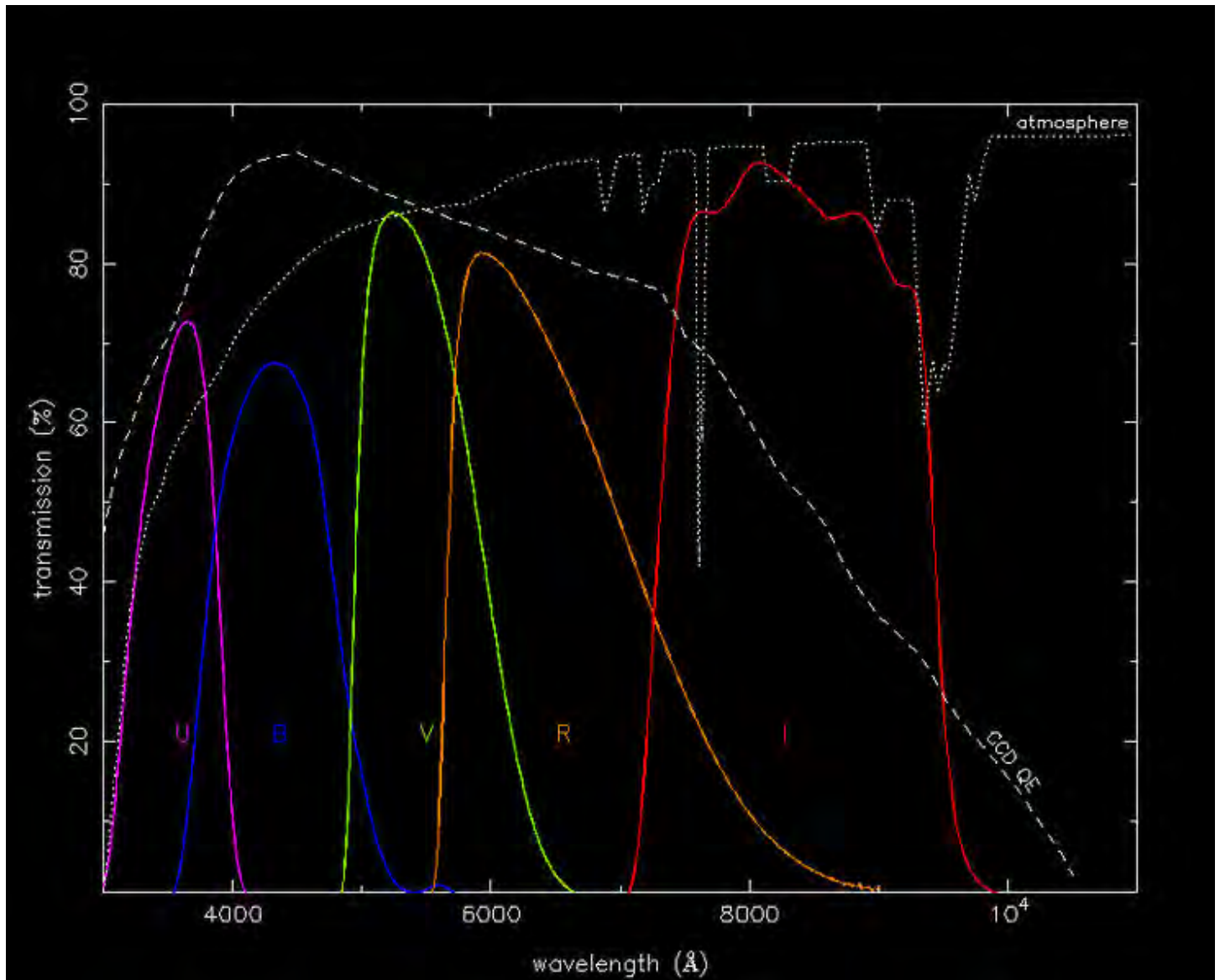


sensor, The Charge Coupled Device or CCD could record an image with higher efficiency than photographic emulsions. The resulting digital image could be analyzed mathematically, enhanced, and combined with previous images to improve the signal-to-noise ratio. The image could also be compared to previous images to locate new objects like nova, supernova, and minor planets.

**Figure 1: Imaging Filters.** Actual UBVRI filters are shown here. The V-filter is green, which is near the center of the eye's spectral response. The U and I filters do not transmit visible light so they look black in this image.

Filters enhance the value of the PEP by providing a measurement of the color of an object. The most often used color index is called B-V (B minus V). The object is measured through a B (blue-violet) filter and a V (visible or green) filter. The magnitudes are computed and then the two magnitudes are subtracted. If the B-V value is zero, the object is the same brightness in the visible as in the blue portion of the spectrum. A negative B-V value means the object is brighter in the blue, like a blue O-type star. A positive value means the object is brighter in the visible like an orange K-type star. There are many other possible color indexes as well.

Another type of filter sometimes used is the polarizer. Using these filters, astronomers can learn about the magnetic field of the object by studying the degree and direction of the light's polarization. Interstellar dust can also polarize light over long distances. Since most stars do not emit polarized light, astronomers can study the amount of dust by looking at the polarization of starlight. Other, more exotic, objects can also be polarized giving astronomers another tool to remote sense the universe.



**Figure 2: Wavelengths of UBVRI Filters.** The spectral response profiles of the UBVRI filter set are plotted against wavelength in the ultraviolet, visible and infrared spectrum. Also plotted are the transmission of the light through the atmosphere at each wavelength (dotted color lines) and the quantum efficiency (QE) of a typical CCD (dashed line).

The most useful instrument is the spectrograph. Originally recording a spectrum of an object on film, spectrographs now record the spectra on CCD detectors. The spectrum show the bright lines of hot atoms emitting light at their characteristic colors and cold atoms absorbing light at those same frequencies. From spectra, astronomers learn more about the composition, temperature and physical state of an object.

Since taking measurements in different part of the visible spectrum was so fruitful, astronomers realized that expanding the range of the electromagnetic (E-M) spectrum observation would provide even more information on the universe. In 1931, Karl Jansky detected radio waves coming from the center of the Milky Way. This opened up an entirely new portion of the E-M spectrum to astronomers. This eventually led to the Very Large Array (VLA) near Socorro, NM and other radio telescopes that observe in different portions of the radio spectrum.

Radio signals from space are faint and need to be concentrated to improve the signal strength. This can be done with a large series of dipole antennas (and their cousins) connected together to boost the signal. For shorter wavelengths, a parabolic antenna can focus the signal just like a parabolic mirror on an optical telescope. At the focus is a waveguide that is sized to select the wavelength to be measured. The waveguide conducts the signal to a low-noise receiver that measures the signal. Just like in the visible spectrum, different radio wavelengths provide different information about the object.

Between the radio and visible parts of the spectrum, there is the infrared. Many parts of the infrared spectrum are blotted out by water vapor in the atmosphere absorbing the signal. Nevertheless, there are dedicated infrared telescopes on high mountains above most of the atmosphere looking at the



**Figure 3: Phased Array.** For low frequency radio telescopes, a phased array of simple dipole antennas will pick up signals in the 50 to 350 MHz frequency range. This array will be built in Western Australia. These antennas actually consist of two dipoles at right angles. A dipole is a simple antenna made of a conductor that is half the wavelength of the desired signal. The dipole is cut in the middle and the two feed wires are connected to two sides of the dipole to feed the signal to the receiver.





**Figure 4: MeerKAT** *One of the 44.3-foot-diameter MeerKAT radio telescope dishes located in the semi-desert Karoo region of South Africa. The off-axis parabolic dish focuses the radio waves toward the off-axis secondary, which sends it on to the waveguide front-end of the receiver. The full MeerKAT array will consist of 64 identical antennas. The MeerKAT array is a precursor to the Square Kilometer Array (SKA).*

infrared sky. The infrared sensors on these telescopes are often cooled to cryogenic temperatures (think liquid nitrogen). This reduces the noise that would otherwise be produced by parts of the telescope and sensors in the optical path. This instrumentation includes spectrometers that record the infrared spectrum and infrared photometers. There are also CCD sensors that are sensitive to the infrared.

A number of infrared telescope satellites have been launched, including IRAS, Spitzer, Herschel and WISE. These telescopes have made great discoveries. Between the ground and space, the Stratospheric Observatory for Infrared Astronomy (SOFIA) infrared telescope mounted in a Boeing 747SP cruises at 41,000 feet out over the Pacific taking images of the sky in infrared. This gets SOFIA above almost all of the water vapor in the atmosphere.

Ultraviolet, X-ray and Gamma Ray astronomy is impossible on Earth. The atmosphere completely blocks this portion of the spectrum. These regions were first explored from stratospheric balloons that carried the instruments above most of the atmosphere. Later, sounding rockets were used to loft the instruments into space for short periods in sub-orbital flights that lasted just a short time, in the range of fifteen minutes. Both of these techniques were used to study the sky from White Sands Missile Range here in New Mexico.

Longer observing time required that the ultraviolet (UV) telescopes be launched into orbit. Missions to observe in the UV include the International Ultraviolet Explorer (IUE), FUSE and Hubble. The telescopes used parabolic mirrors, but visible-wavelength coatings did a poor job of reflecting UV light. Special coatings had to be developed to reflect more of the ultraviolet light to the detector.

CCDs are again a major detector of ultraviolet light, but UV does not penetrate far enough into silicon to knock out electrons like visible light. Techniques have been used like overcoating the CCD with UV-sensitive phosphorus that absorbs UV and emits visible light for the CCD to detect. The CCD can be made to detect UV directly by carefully thinning (polishing away) the back of the CCD “chip” so the



**Figure 5: MSSTA.** *The Multi-Spectral Solar Telescope Array (MSSTA) is inside its stainless steel protective skin (the silvery section at the top of the missile). Below the telescope is the Black Brant sustainer stage and at the bottom is the Terrier solid rocket booster. This assembly is NASA sounding rocket 36.049 at White Sands Missile Range, in May 1991. The MSSTA array is composed of fifteen telescopes designed to observe the Sun in ultraviolet and soft x-rays.*

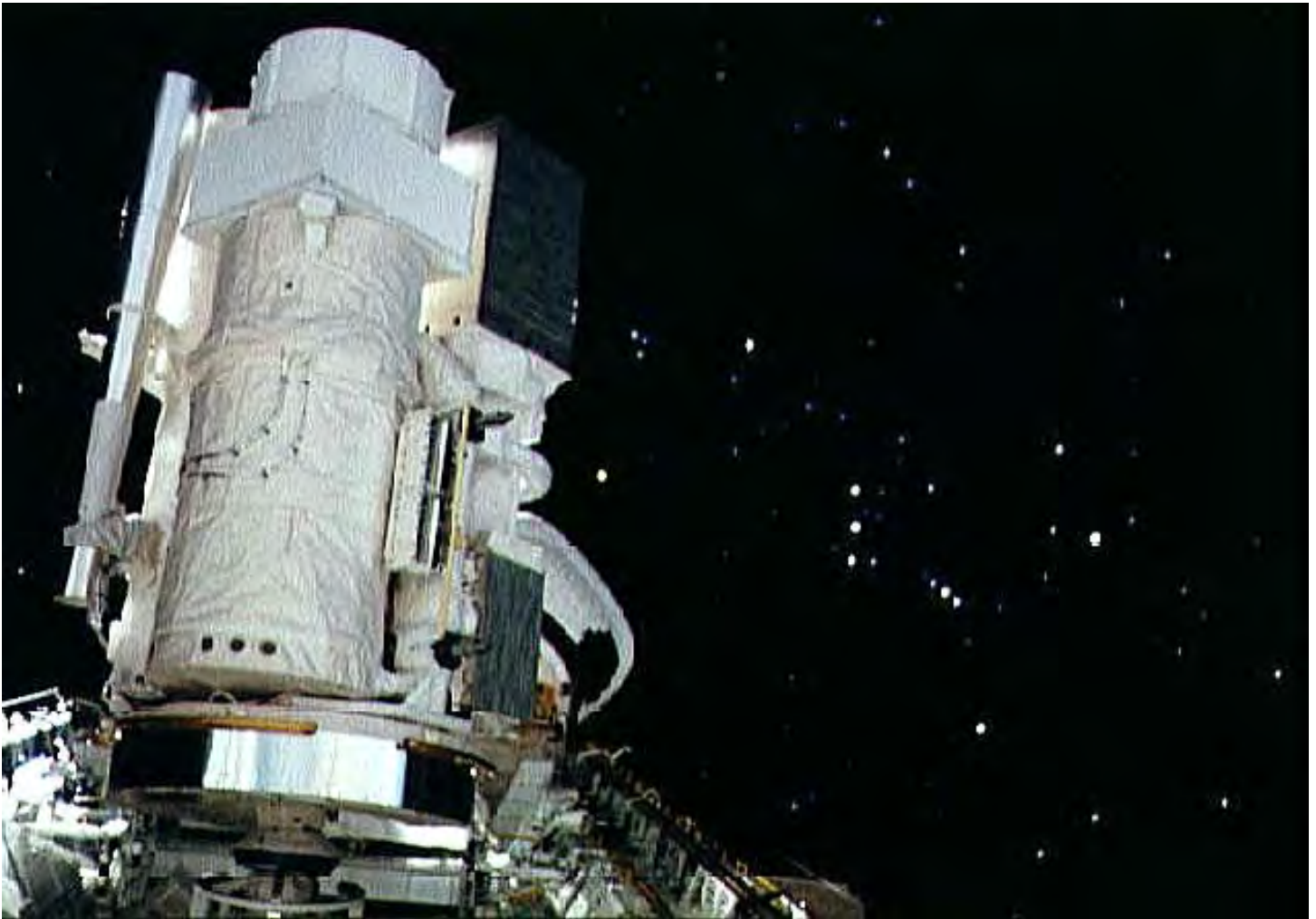
UV photon can reach the active cell of the CCD to knock out an electron. CCD detectors are rugged enough to survive a launching and have contributed to our knowledge of the universe.

X-ray and gamma ray astronomy can be grouped together. They both will not reflect like light from a high-incidence mirror like we have in our telescopes. These high-energy photons will be either absorbed by the mirror or pass right through it. One way to focus high-energy photons is to use two grazing incidence mirrors. HE photons strike a parabolic mirror segment at a very shallow angle, reflecting the photon. A second parabolic mirror segment increases the bending of the photons sending them toward a focal point.

A number of satellites have been deployed to look in the high-energy spectrum, using this type of focusing element, including Swift, Chanra, Compton, XMM-Newton and ROSAT. Many of these orbiting observatories are still in operation.

The detectors at the focus varied depending on the spacecraft. One type is a proportional counter that uses a gas-filled tube. The gas is ionized by a high-energy photon, allowing an electrical current to flow through the tube, sending a pulse to a counter. This was used as a part of the Apollo 15, EXOSAT, and the Apollo-Soyuz missions.

Scintillation detectors convert high-energy photons into visible-light photons that can be detected by photomultiplier tubes. The scintillator is often a crystal, sometimes sodium iodide or cesium iodide. The



**Figure 6: Astro 1 Observatory.** *In the cargo bay of the Space Shuttle Columbia is the Astro-1 observatory consisting of three ultraviolet telescopes and one X-ray telescope. This telescope array was designed to fly on multiple missions. The Ultraviolet Imaging Telescope (UIT) and the Wisconsin Ultraviolet Photopolarimetry Experiment (WUPPE) covered approximately 1200-3200 Angstroms. The Hopkins Ultraviolet Telescope (HUT) covered the spectral region from 425 to 1850 Angstroms. Finally, X-ray data was gathered in the wavelengths between 0.3 and 12 keV by the Broad Band X-ray Telescope (BBXRT).*

Orbiting Solar Observatory Four (OSO 4) carried such a detector as did the Kvant-1 module connected to the MIR space station.

There are other types of x-ray detectors, including CCDs. In the CCD, the x-ray photon releases hundreds to thousands of electrons, depending on the energy of the photon. On readout, the energy of the photon can be determined from the “brightness” of the CCD pixel. The Chandra X-ray Observatory carries such a detector.

Remote sensing of the Earth has only been around for fifty-six years. Remote sensing of the universe using everything from the human eye to the CCD has been around for much longer. We have learned virtually everything we know about the universe from our remote sensing of the sky.

\* \* \*

# **Tone Mapping for Better Images**

**Alex Woronow, Black Range Observatory**

*“Tone Mapping is selectively altering brightness within a scene, which attempts to preserve local contrast where the eye expects to see it, while shifting brightness in ways less apt to be noticed across an image to still compress global contrast. As such, HDR tone mapping is best understood as a form of optical illusion.”* Bob Johnson, photographer

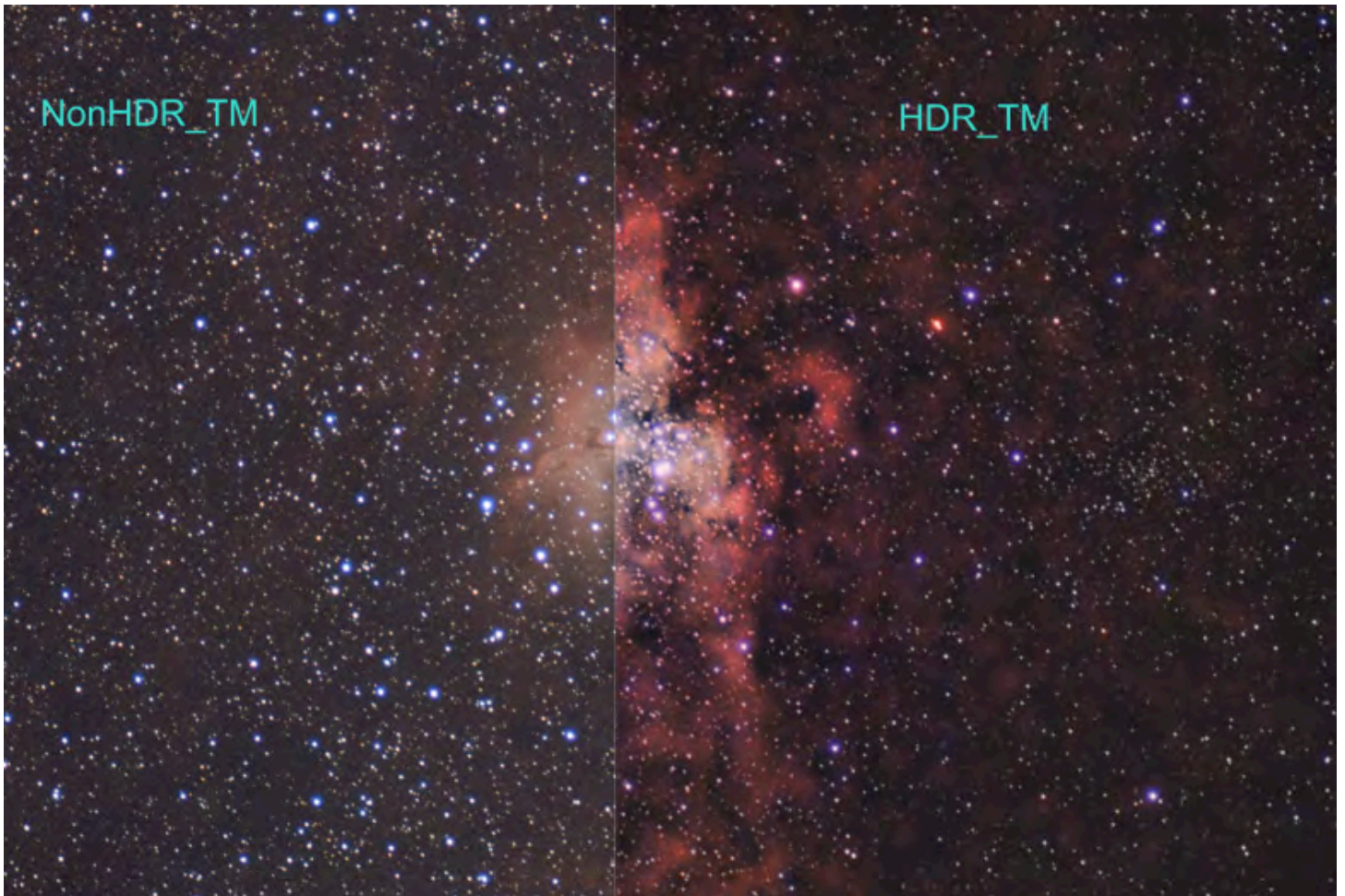
## **Introduction: The Problem**

Have you ever collected too many hours of images on a single target? Well, if you have, then you probably belong on a pedestal and you'll probably be very lonely up there. The vast majority of astro-images never accumulate enough, no less too much, image-integration time. Yes, some brighter targets, like M42, can be over-exposed in just minutes. But most targets require hours of exposure, composed of shorter, perhaps 1 to 20 minute, exposures in multiple colors. One-shot color cameras generally require at least as much total exposure time as the cumulative exposure time spent shooting through individual red, green, and blue (RGB) filters. Imaging through narrow-band filters (commonly Hydrogen alpha, Sulfur II, and Oxygen III, or “HSO” for short) requires even more exposure time because the narrow band filters eliminate so much out-of-band light. So, let's start with the premise that you have disappointing dearth of exposure time in multiple colors or narrow bands. Also let us assume that your target was faint. With our meager suite of limited exposures in hand, how do we produce exciting renditions of these objects—something more similar to the right-hand side of Figure 1 rather than the left-hand side?

We simply ‘push’ or enhance the nebula—it's really that straight forward (to say, if not to do). The problem we have is that the dynamic range of our image is often nearly fully populated, from faint to bright. At the faint end lies our target, often occupying just a few bits of the camera's dynamic range. Toward the bright end reside the few brightest stars. If we push the image to reveal the nebula, we risk badly saturating the stars. To demonstrate our solution to this problem, we will process a set of 10 exposures of 60 seconds each of M16, the Eagle Nebula. (Taken with a Canon 550D, unmodified; target was low in the SW sky.) If we express the pixel's gray-scale from 0 to 1 (black to white), the individual subframes have background sky levels of about 0.005; nebula brightness levels range from that background value up to about 0.05; and a few stars just reach saturation in their cores at 1.0. Those stars limited our subframe-exposures to a scant 60 seconds. Our target, the nebula, really just pokes its head above background in any unenhanced version of the image (Figure 2) and could go unnoticed in such an image. As stated above, simple linear stretching (e.g., multiplying all brightnesses by a constant) saturates the stars, and really does little toward enhancing the nebula. Common non-linear stretches, such as the exponential stretch,  $B_1 = 1 - (1 - B_0)^K$ , where  $B$  is brightness and  $K$  is a positive constant, can greatly stretch faint features and almost leave bright objects unaltered. Such exponential stretches reveal the faint nebula, but often do not carry the visual impact we desire. The nebula itself still has a limited intensity and contrast range that suppresses the “stunning” detail we seek.

## **What is “Tone”?**

Strictly speaking tone is a mixture of a color with a shade of gray. So, to “tone down a color” we would add a shade of gray to the color. “Tone” is closely related to “tint” (where white is added to a color) and “shade” (where black is added to a color). (BTW, a “hue” is just one of the 12 colors of the color wheel.) The site <http://color-wheel-artist.com/hue.html> might help explain and illustrate the differences. Now, given the quote heading this article, one might reasonably assume that Tone Mapping (TM) involves adjusting the gray content of an image component in a manner dependent upon that component's original gray content. That assumption is pretty accurate.



**FIGURE 1:** PROCESSING OF THE LEFT HALF OF THIS IMAGE OF THE EAGLE NEBULA (M16) USED SIMPLE NON-LINEAR STRETCHING WHILE THE RIGHT HALF EMPLOYED HIGH DYNAMIC RANGE AND TONE MAPPING ENHANCEMENTS.

### Masks

Before launching into tone mapping per se, we'll start with a word about using "masked" operations on images. Many image-processing platforms have the ability to generate various types of masks. In PixInsight, a mask is a grayscale image of the same dimensions as the target image that mediates image-processing operations (e.g., brightening or contrast enhancement) applied to the target image. Where the mask is white, the full brunt of the operation impacts the target image; where the mask is black, the operation has no effect. Levels of gray in the mask allow corresponding levels of effect. Below we will construct a nebula mask. If we build an effective mask, then that mask will allow us to manipulate the tones and contrasts of the Eagle Nebula without affecting the stars or nebula-free background. Referring again to the lead-in quote, tone mapping selectively operates on an image. We selectively target the nebula, of course. But, in the process of making our nebula mask, we will blur its edges. This is a common manipulation applied to masks that operate on broad features with vague extents. Blurring introduces gradual transitions from brighter to darker grays and tapers out the applied effects of operations on the image.



**FIGURE 2:** A SINGLE 1-MINUTE CANON T2I IMAGE OF THE EAGLE NEBULA THROUGH A 5.5” REFRACTOR. THE EAGLE NEBULA IS TOO FAINT TO SEE READILY IN THIS IMAGE, ALTHOUGH THE IMAGE SHOWS SEVERAL STARS.

### **Tone Mapping Reviewed**

Tone Mapping developed in the mainstream of digital imaging, where it rightfully resides in the realm of high-dynamic-range (HDR) image processing. So, a few words about HDR processing, in general, serve as a good introduction to TM.

Even the cameras on smart phones have apps that now support HDR imaging—the concept is quite simple. If a scene has deep shadows and bright highlights, then the exposure that reveals detail in the former will washout the latter, and the exposure that reveals detail in the latter will leave the former without much detail. So, why not take two exposures, one long and one short, and combine them in some seamless way so that both light and dark picture elements show to their best? That is exactly what HDR imaging does. This is not usually practical for astro-imaging because most targets wholly lie in the under-exposed category! Nonetheless, a few targets, M42 prime among them, benefits enormously from this technique.

*See <http://www.astropix.com/HTML/BEGINNER/M42HDR.HTM>*

Besides TM, astro-image-processing techniques that have ties to HDR algorithms include “masked stretch,” “Local-Histogram Equalization,” and “HDR compression.” PixInsight hosts these tools, the latter as HDRMultiscaleTransform, and GIMP has the latter technique too. In CS2, some HDR tools were available, and ON1 10 has such tools too. I am not familiar enough with other image-processing programs to know if they implement either or both.

Returning to “masked stretch,” however, basically, it incrementally stretches an image while masking out the brightest stars at each step, to stop increasing their brightness before they saturate or exceed the brightness of the next brighter star. A faint nebula never gets masked and gets the most stretching. This procedure does not focus specifically on enhancing the nebula, however. Generally, digital cameras have considerably higher dynamic ranges than do computer displays and printers. HDR-compression reduces the overall dynamic range of the image with brighter objects receiving more compression in their brightness than do fainter ones. This remapping of tones can increase the apparent detail content of an image displayed by a computer or printer. And Local Histogram Equalization simply attempts to increase local contrasts, often boosting subtle details in the image. These are valuable processing tools, and easy to use, but TM should also be part of the toolbox used to improve image detail and impact.

Important Note: TM, as done in astro-imaging, naturally targets the principal subject matter of the image (e.g., a nebula). As such, we try to isolate that subject matter from the rest of the image, namely from the stars and the background. Neither stars nor background should participate in the procedures used to enhance the nebula. If we have a color or multiband image, then the nebula in each color or band could undergo separate enhancements through TM and subsequently be combined into a single image. Of course we could use the same color/band separations for processing the stars and background; sometimes adding value to the outcome, and sometimes not.

### **Tone Mapping by Star Removal**

Perhaps you’ve seen images with the stars removed, such as those of J-P Metsavainio (an early advocate and innovator of TM applied to astro-images). For example,

**<http://astroanarchy.blogspot.com/2014/06/a-collection-of-starless-veil-nebula.html>**

For his version of TM, removing the stars from an image constitutes the first step. His web site has a tutorial enumerating the steps necessary to implement TM in PhotoShop (PS). Basically, the approach involves repeated applications of PS’s dust/scratch removal action to eat away the stars and to fill in with interpolated nebula. Results vary! The dedicated program Straton uses a proprietary algorithm to remove stars, and does a fair job. StarTools can “Heal” stars away too. Other programs could also achieve star removal through a similar, but nonautomated process. “On1 10” has a “magic eraser” that removes unwanted picture content and interpolates the image through that region. PI’s TVGInpaint, with an inverted star mask as a “bad-pixel map” can also do a somewhat creditable job of star removal. However, in all these cases, the final image is not a mask isolating the nebula but an image that contains both nebula and background. The fact that the star scars have been ‘healed’ provides no benefit for TM. TM works just as well if we simply masked out the stars. (For artistic reasons alone, some image processors now produce star-free final renditions of nebula and several of the above methods facilitate that objective, which differs from the objective of TM.) Enhancing a nebula+background image by TM, or any HDR technique, probably implies that the background detail is “enhanced” too. In reality, background detail largely consists of noise, which we do not want to enhance!

### **Tone Mapping (Example Approach)**

Let’s say we start with the one-shot color images described at the top of this article. First step, after calibrating each subframe, stacking them, removing background gradients, and neutralizing the image backgrounds, is to stretch the stacked images. I used masked stretch, to yield the image in Figure 3. Recall, masked stretch already reaches into the HDR bag of tricks, and does more than, say, simple histogram or nonlinear stretching. So, the nebula in Figure 3 appears more obvious than it

would with nonHDR stretches. This image (Figure 3), we decomposed into its RGB components, each to be treated separately. Alternatively, the initial stacks might be HSO components, perhaps along with luminance, or some other set of imaged bands. Now, if we could isolate the nebula in each of those individual stacks, then we could manipulate its brightness and contrast in each sub-image and, effectively, map the tones (gray levels) initially associated with the nebula to any other tones and any desired range of tones (or, for that matter, to any different colors/tints). Furthermore, we can recombine the RGB in any proportions we choose. We can intensify some color ranges and subdue others, and so forth. But, our first concern is, how do we isolate the nebula from the stars and background so we can attack its tonal range separately?



**FIGURE 3:** STACK OF A MERE 10 FRAMES OF 1-MINUTE EXPOSURES OF THE EAGLE NEBULA (M16). BACKGROUND WAS FLATTENED, NEUTRALIZED, AND A MASKED STRETCH APPLIED. THIS IMAGE CONSTITUTES THE STARTING POINT FOR THE TONE MAPPING.

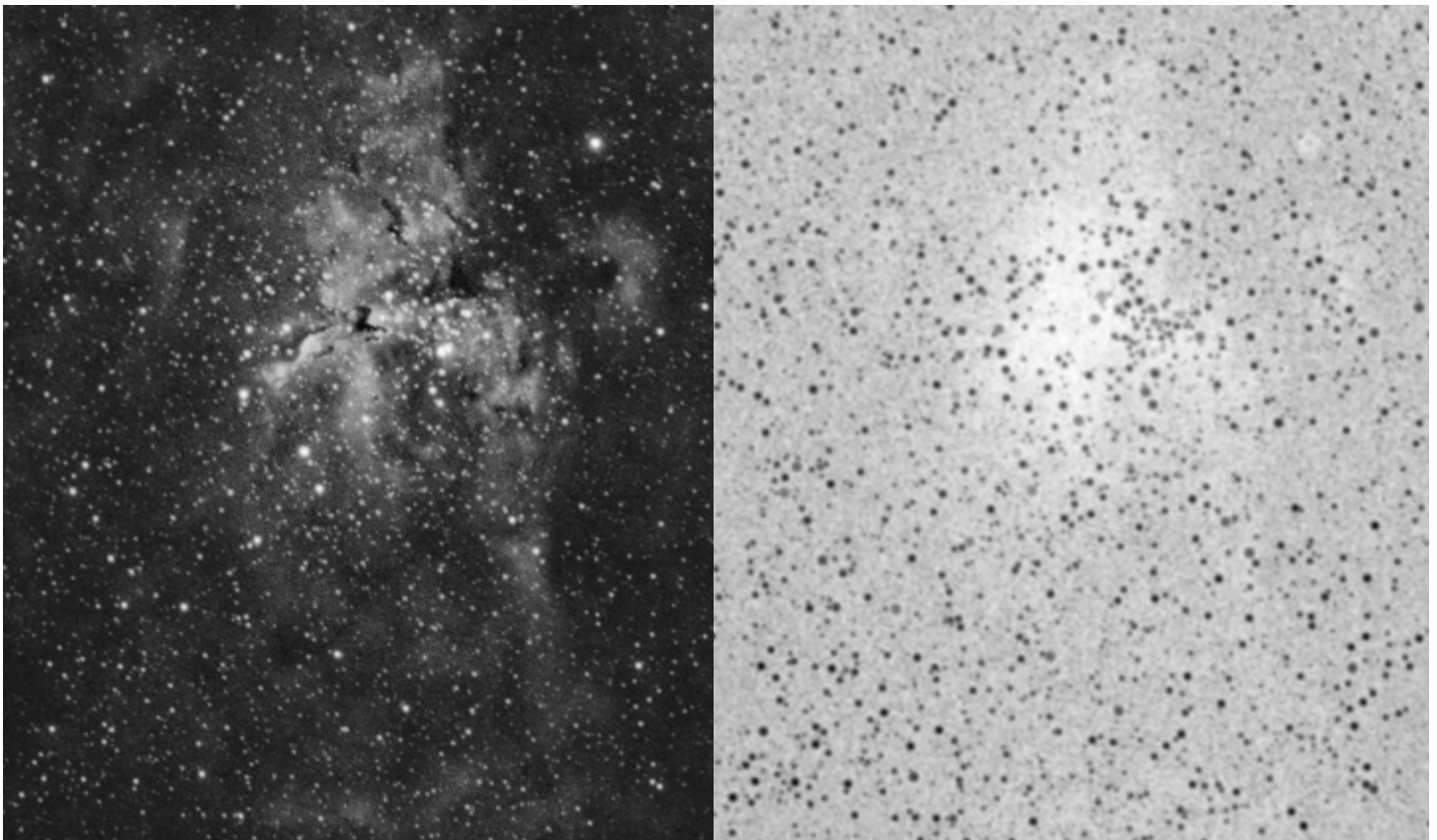
Let us begin with the red channel. Call the red channel extracted from the image in Figure 3 “initial\_R,” which Figure 4 shows, in part. We make a star mask specific to this image, also shown in Figure 4. This star mask used the default values in PixInsight (probably should have increased the Scale parameter a little). If we invert the star mask (make white become black and vice versa) and drag it over the image on the left, it will protect the stars from any operations performed on the image. Let us name the star-mask “star\_mask\_R.” With the mask in place, if we stretch the image on the left, the stars should not be brightened significantly, for instance. That is just a part of the protective mask that we need. The other mask part we need will protect the background. Because, without a mask protecting the background, if we “push” (aka, brighten or stretch) the nebula, the background will also brighten and the contrast between the nebula and background will remain about the same. The nebula will not stand out. Furthermore, we like to think of the night sky as nearly black, and a sky rendered with obvious



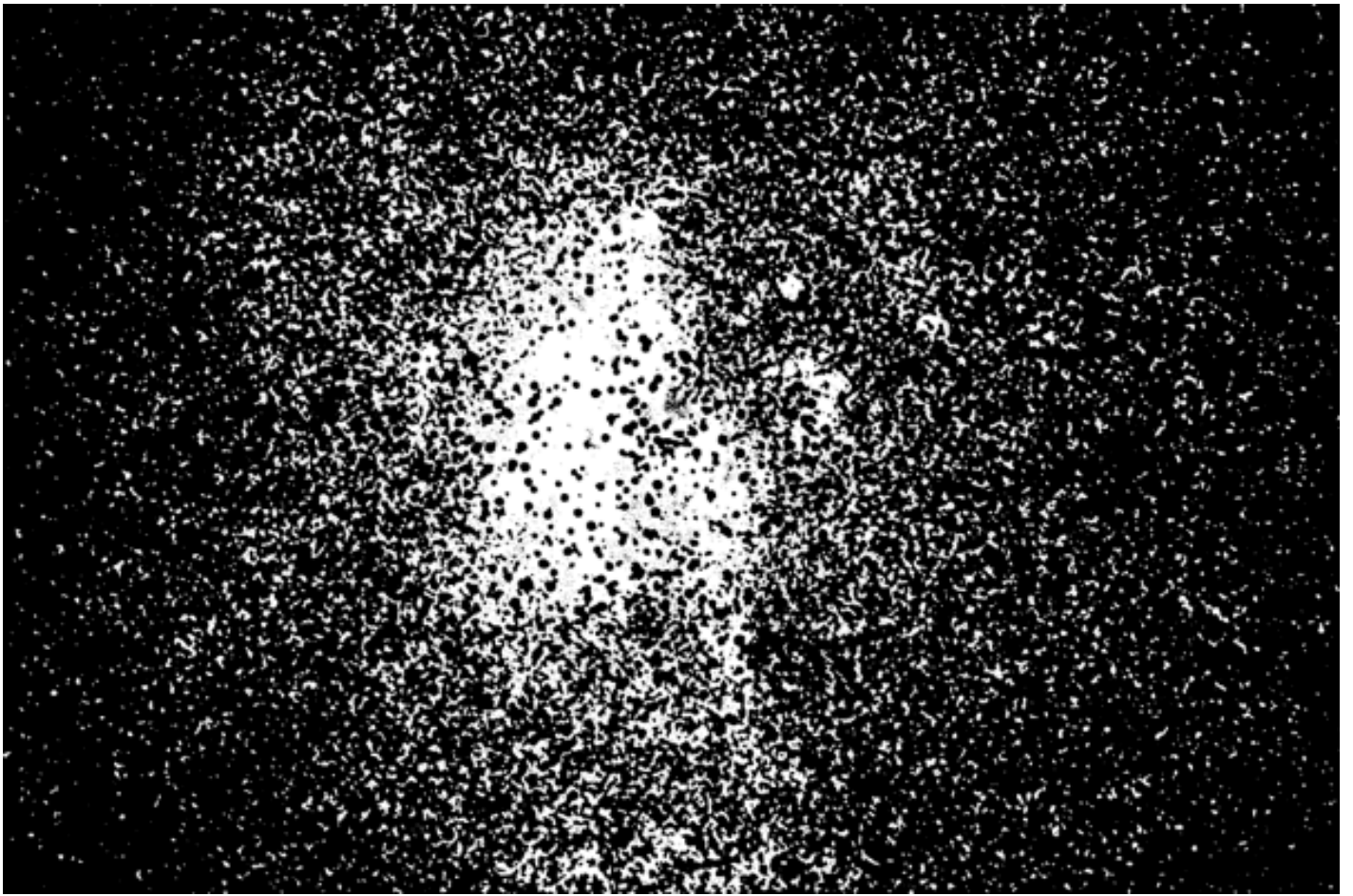
brightness will not be aesthetically pleasing. Therefore, we need a mask to protect not only the stars, but the background too. This background+stars mask we construct using the PixelMath tool in PI. Other programs usually have similar capability either imbedded in them or as plugins. We use the equation, in the jargon of PI,

$$\text{iif}(\min(c - \text{star\_mask\_R}, \text{initial\_R}) < b, 0, 1) \quad (\text{EQ1})$$

to make the background+star mask, or, its inverse, the nebula mask. This equation has two adjustable variables, c and b. For a start, try c:  $0.3 < c < 0.4$ . Reasonable values for b are quite small, probably  $< 0.1$ . Adjust them by trial-and-error until you achieve a good mask: one that has the nebula region white and the stars and background black. The equation directs the program to do the following: for each pixel in our image, subtract its gray-scale value (intensity) in the star\_mask\_R from c and compare it to the corresponding pixel value in the initial\_R image. If the minimum value of that pair is less than the value of b, then set the output pixel to black (0) otherwise set it to white (1). (The “iif” is just PI’s way of expressing the keyword, “if.”) Figure 5 shows the result of applying EQ1 to our example image.

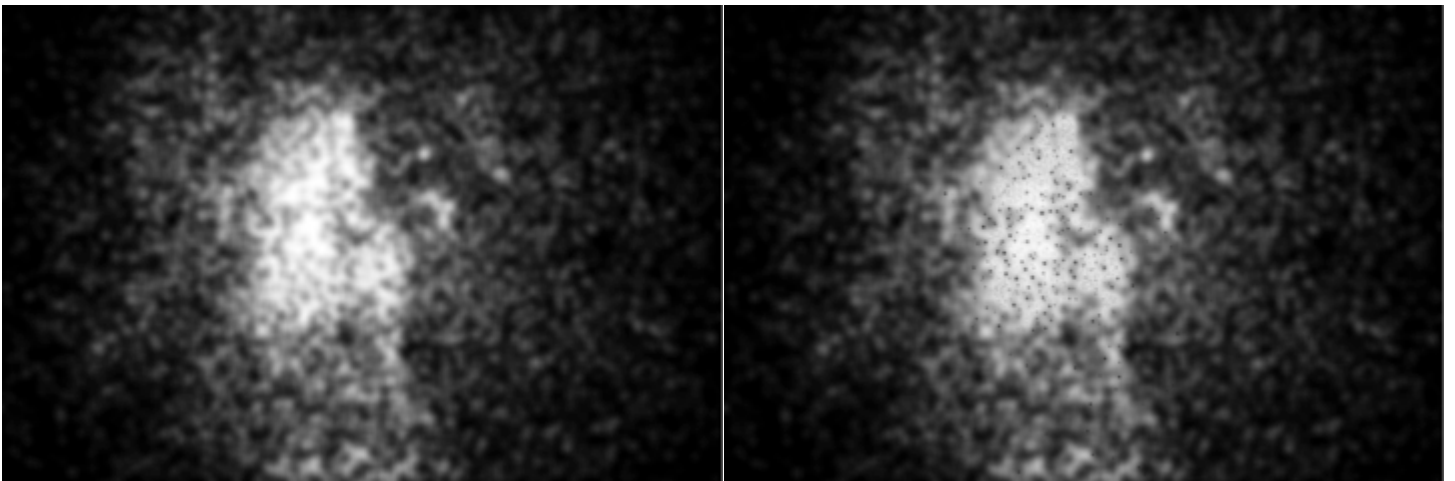


**Figure 4:** THE RED COMPONENT OF THE EAGLE NEBULA (LEFT) AND THE CORRESPONDING STAR MASK (RIGHT). A CENTRAL PORTION OF FIGURE 3 IS SHOWN HERE. THE RED COMPONENT HAS BEEN EXTRACTED FROM THE IMAGE SHOWN IN FIGURE 3.



**Figure 5:** THE OUTPUT FROM EQ1 APPLIED TO THE EAGLE NEBULA EXAMPLE (FULL FRAME). THE MASK-PROTECTED REGIONS ARE BLACK. THE NEBULA ACTUALLY COVERS THE ENTIRE IMAGE, BUT PREDOMINATES WHERE THIS IMAGE IS MOSTLY WHITE. THOSE PARTS WILL RECEIVE THE GREATEST DEGREE OF ENHANCEMENT.

Next, we take the mask shown in Figure 5 and blur it mercilessly to get the mask in Figure 6 (Left). This was accomplished by deleting the shorter A Trous wavelets in the image, retaining only wavelets  $>6$ . A Gaussian blur, or convolution, could have accomplished the same goal of a smoothed mask. Then, just to make sure that the stars are not dragged along in the TM process, we re-introduce the star\_mask\_R to this blurred mask (using PixelMath again). The result appears in Figure 6 (Right).



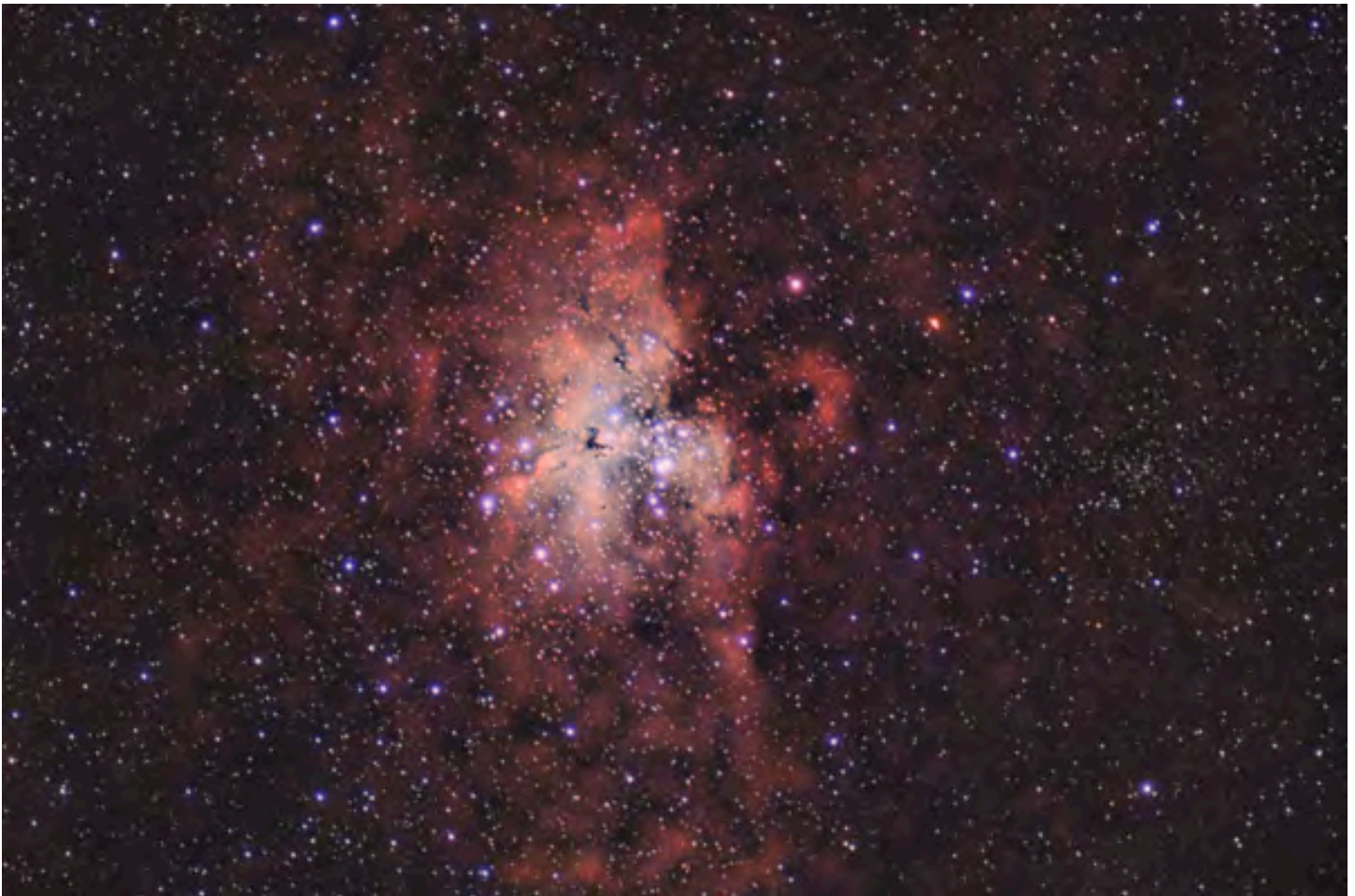
**Figure 6:** THE NEBULA MASK: BY REMOVING THE SHORT-WAVELENGTH WAVELETS (1 TO 6) FROM THE MASK IN FIGURE 5, WE OBTAIN THE BLURRED/SMOOTHED MASK SHOWN ON THE LEFT. RE-INTRODUCING THE STAR MASK, ADDING IT TO THE LEFT IMAGE, WE GET OUR FINAL NEBULA MASK (RIGHT). ONLY THE NEBULA UNDERLIES THE WHITE AND LIGHT GRAY REGIONS OF THIS MASK.



**Figure 7:** *THE RED CHANNEL OF THE EAGLE NEBULA AFTER TM USING MASKED PROCESSES DESCRIBED IN THE TEXT.*

Finally, we apply the mask (Figure 6 Right) to the red component of the stretched image (Figure 4 Left) and begin to manipulate the red-channel tonal data to achieve the aesthetics we desire. In this case, I kept it pretty simple with just two operations: a HDR Multiscale Transform and a Local Histogram Equalization. The former suppresses noise and enhances contrast among features of different sizes. The second then spreads out the dynamic range, as well as enhancing contrast to reveal detailed structure in the nebula. Figure 7 shows the resulting processed red channel, which now has a nebula intensity that extends from nearly 0 for the background to beyond 0.8.

We still have work to complete. We must build masks for the blue and green channels and apply appropriate enhancing to those channels. In this case, we follow exactly the same procedures of mask building and masked processing steps, although that need not be so. Alternatives might involve using the red mask on the G and B channels too, or producing a single mask from the composite RGB image, for instance. But, proceeding with separate processing of each color channel, once we have the equivalents of Figure 7 for the G and B channels, we combine them. I have combined them in equal amounts, for this example. After that, the color image can be manipulated with other operators, such as curve transformations and saturation adjustments. For many of those I first masked the color image using the red-channel nebula mask. The red-channel adequately covered the features I wished to manipulate. A new mask could have been constructed, and a separate star mask could also be imposed to manipulate star colors and saturation separately from that of the nebula and background. In any case, Figure 8 shows my final result. I have not tried to mitigate the violet halos around the brighter stars (from an achromatic refractor), although that could be done too, perhaps using PI's color mask script. Nonetheless, if something about my final product runs counter to your taste, the ability to isolate



**Figure 8:** THE COMPLETED TONE MAPPING OF THE EAGLE NEBULA (M16). COMPARE THIS IMAGE TO ABOUT THE SIMPLEST HDR PROCESSING POSSIBLE (MASKED-STRETCH ONLY), AS SHOWN IN FIGURE 3. PARTICULARLY NOTICE THE NEBULA'S PRESENCE ACROSS THE ENTIRE IMAGE, WHICH FIGURE 3 POORLY REVEALS.

the stars, nebula, and background individually, as well as to manipulate each color channel separately, should allow you to build the image you find most aesthetically pleasing!

Like most image-processing tasks, experimentation and logging your procedures and results helps achieve the desired output and develop fluency with the technology. Also, just for the record, all images in this article are simply screen grabs. The quality, therefore, only vaguely relates to detail and quality available in the actual image products. But the concept, I believe, is adequately demonstrated. If you would like to correspond with me on this article's content, email me at [alex@awkml.com](mailto:alex@awkml.com) or corner me at an ASLC meeting.

**CHEERS!**

\* \* \*

## ***Telescope for Sale:***

Member Roy Willoughby has a Next Generation Telescope (NGT-18) for sale. This is an observatory-quality 18 inch F4.5 Newtonian telescope on a portable equatorial split ring tracking mount with a NGC-MAX sky object finding computer system. The high quality "Galaxy" mirror is housed in an eighteen-point flotation cell. Also included is a separate motorized lifting system for transport to observing sites. This originally sold for \$10,000 and I am asking only \$5,000 for the complete telescope and transport system. Attached are four pictures. Please contact me at 524-9392 or email me at [rswillowbee@comcst.net](mailto:rswillowbee@comcst.net).



# Astronomical Society of Las Cruces

## Ballot for 2017 Society Officers

And

## 2016 Annual Meeting Announcement

Vote for one (1) candidate for each position **OR** write-in the member of your choice:

Position:		Candidate		Write-in
President-		<input type="checkbox"/> Howard Brewington		<input type="checkbox"/>
Vice-President-		<input type="checkbox"/> Rich Richins		<input type="checkbox"/>
Treasurer-		<input type="checkbox"/> Patricia Conley		<input type="checkbox"/>
Secretary-		<input type="checkbox"/> John McCullough		<input type="checkbox"/>

Vote for two (2) of the candidates below **OR** write in the member of your choice:

Position:		Candidate		Write-in
Director-at-Large (Position #1)		<input type="checkbox"/> Sid Webb		<input type="checkbox"/>
Director-at-Large (Position #2)		<input type="checkbox"/> Ed Montes		<input type="checkbox"/>

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Member Signature
Printed Name
Date

**Note:** Write-in candidates must be current voting members of the Astronomical Society of Las Cruces (ASLC) and agree to serve if elected.

For confirmation purposes, please sign and date your ballot. Mail or email your ballot to the Secretary and/or the Elections Committee at P.O. Box 921, Las Cruces, NM 88004 or [Secretary@aslc-nm.org](mailto:Secretary@aslc-nm.org) to arrive no later than 27 October 2016. Ballots may also be hand delivered or cast at the Annual Meeting.

### 2016 ANNUAL MEETING ANNOUNCEMENT

The Annual Meeting of the Astronomical Society of Las Cruces will be held at 7:30 pm on 28 October 2016 in the Creative Arts/Activities Room, Good Samaritan Society-Las Cruces Village, 3011 Buena Vida Circle, Las Cruces, NM.



# Astronomical Society of Las Cruces Loaner Telescopes 1



Celestron Power Seeker 114AZ. 114 mm Newtonian. Focal length 900mm. Model #210656- View finder included. Mount: Small tripod with fork mount. Good condition



Two separate telescopes. Meade ETF 90 AT. Table top mount. Good travel case. History of problem with controller. Being repaired.



