

# The High Desert Observer

## June 2017



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

Individual Dues are \$30.00 per year

Family Dues are \$36.00 per year

Student (full-time) Dues are \$24.00

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

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

### ASLC Board of Directors, 2017

[Board@aslc-nm.org](mailto:Board@aslc-nm.org)

President: Howard Brewington; [President@aslc-nm.org](mailto:President@aslc-nm.org)

Vice President: Rich Richins; [VP@aslc-nm.org](mailto:VP@aslc-nm.org)

Treasurer: Patricia Conley; [Treasurer@aslc-nm.org](mailto:Treasurer@aslc-nm.org)

Secretary: John McCullough; [Secretary@aslc-nm.org](mailto:Secretary@aslc-nm.org)

Director-at-Large: Sidney Webb; [Director1@aslc-nm.org](mailto:Director1@aslc-nm.org)

Director-at-Large: Ed Montes [Director2@aslc-nm.org](mailto:Director2@aslc-nm.org)

Immediate Past President: Daniel Giron; [astrofix@comcast.net](mailto:astrofix@comcast.net)

### Committee Chairs

ALCor: Patricia Conley; [tconley00@hotmail.com](mailto:tconley00@hotmail.com)

Apparel: Howard Brewington; [comet\\_brewington@msn.com](mailto:comet_brewington@msn.com)

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

Education: Rich Richins; [Education@aslc-nm.org](mailto:Education@aslc-nm.org)

Grants: Sidney Webb; [sidwebb@gmail.com](mailto:sidwebb@gmail.com)

Loaner Telescope: Sidney Webb; [sidwebb@gmail.com](mailto:sidwebb@gmail.com)

Membership: Judy Kile; [judykile3916@gmail.com](mailto:judykile3916@gmail.com)

Observatories:

Leasburg Dam: David Doctor; [astrodoc71@gmail.com](mailto:astrodoc71@gmail.com)

Tombaugh: Steve Shaffer; [sshaffer@zianet.com](mailto:sshaffer@zianet.com)

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

Web-Site: Steve Barks; [steve.barks@gmail.com](mailto:steve.barks@gmail.com)

HDO Editor: Charles Turner; [turnerc@stellanova.com](mailto:turnerc@stellanova.com)

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



### Table of Contents

- 2 *What's Up ASLC*, by Howard Brewington
- 3 *Outreach Events*, by Jerry McMahan
- 4 *Calendar of Events, Announcements*, by Charles Turner
- 5 *May Meeting Minutes*, by John McCullough
- 6 *Back at the Telescope*, by Berton Stevens
- 12 *Sub-frame Weighting in PI*, by Alex Woronow
- 18 *Photos of the Month: C. Sterling, J. Gilkison, J. Kutney, C. Brownnewell, J. Johnson, A. Woronow*
- 24 *Eclipse Novel Snippet*, by Lars D H Hedbor

### June Meeting --

Our next meeting will be on **Friday, June 23**, at the Good Samaritan Society, Creative Arts Room starting at 7:00 p.m. The program will be about May's Star Parties and The ASLC photo contest

### 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.

### Events

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

At our Leasburg Dam State Park Observatory, we hold monthly star parties. Located just 20 miles north of Las Cruces, our 16" Meade telescope is used to observe under rather dark skies. Please see *Calendar of Events* for specific dates and times.

# What's Up ASLC?

June 2017

As happened in April, May's Moon Gaze event was also cloudy, so Chuck, Jerry, and I enjoyed a cup of coffee at International Delights Café as we waited for conditions to improve. Although we've been doing public outreach at that location for many years, new construction next to Albertson's is now blocking a great deal of the eastern sky. So, we're considering new locations. Later in the month, sky conditions were more favorable, and our star parties at Tombaugh and Leasburg observatories enjoyed large crowds. Our guests were treated to views of the moon and the planet Jupiter. It's still a bit early for Saturn, but that crowd pleaser should be available in the early evening by July. These public observing sessions are a great way for new (novice) members to learn some basic astronomy as well as have the opportunity to see/use various types of telescopes.



Speaking of telescopes and observing sessions, May was the month of star parties for several ASLC members. Steve Barks organized a week of star gazing and imaging at the Cosmic Campground, which is north of Silver City. John Cutney, Chuck Sterling, and Kirby Benson checked out Rusty's RV Ranch in Rodeo, NM as a possible site for future star parties. And, I went to the Prude Ranch near Fort Davis for the annual Texas Star Party. Although several ASLC members usually attend TSP, I was the only person representing our club this year.

My first TSP was in 1991, but this star party began in 1979. First conducted as a weekend of star gazing at the Davis Mountains State Park, TSP moved to the Prude Ranch in 1982 and became a weeklong orgy of dark-sky observing. I've been to Stellafane in Vermont, the Winter Star Party in the Florida Keys, the Riverside Telescope Makers Conference near Big Bear Observatory in California, and the Okie-Tex Star Party in the panhandle of Oklahoma. However, the Texas Star Party is one of my favorites, and it's only a four-hour drive south of Cruces.

Although this was my fifteenth TSP, the ranch still looked the same except for attendance. About 750 guests has been the norm in past years, but only 375 registered for 2017. So, the upper and central observing fields looked less populated of course, and the lower field, where I set up my equipment in 1991, was completely bare. In my opinion, though, the ranch struggles to accommodate a guest list in the 700s, so I was okay with the reduced numbers. I was surprised, however, to see a small light dome northeast of the ranch. I learned that a distant oil drilling/processing operation was causing the sky glow. But, when the oil dries up, the lights will go out. The Prude Ranch is still a very dark site as compared to the rest of the United States, and I look forward to the Texas Star Party each and every year.

Howard Brewington  
ASLC President

\* \* \*

## **Outreach**

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

### ***Outreach Events***

by Jerry McMahan

#### ***Moongaze, Saturday, May 6***

Howard Brewington, Chuck Sterling and I attended. Coffee was consumed, stories were told, but no scopes were set up. It was cloudy with some raindrops falling, so no observing was done.

#### ***Highland Elementary, Friday, May 12***

This was a Solar scope only event since it ended before Sunset. Chuck Sterling, Steve Shaffer, Tracy Stuart and Jerry McMahan used scopes with white light filters. Howard Brewington had the club's hydrogen alpha single stack scope. What did we see? Basically nothing since there were no Sun Spots at all, just a featureless disk. Howard did get a small prominence, but I had trouble even seeing that.

Chuck did use his new invention, his cell phone with an Astronomy application, was used as a finder to get a daytime view of Jupiter. It took a while because Jupiter was behind some slow moving clouds. When he did get the planet, he said he missed it by a few degrees. It is a technique that he is still working on. Chuck had requested that we set up on the basketball court, rather than on the grass where we usually set up at this school. That request paid off since when we left, we saw that sprinklers had come on. Water and telescopes are not a good mix.

#### ***Leasburg Open House, Saturday, May 20***

I was sick and not able to attend this event, so I apologize to any one that is being left out in this second hand report. The observatory was opened, but no telescopes were set up out. A number of club members attended. They included, I think, Bob Armstrong, Sid Webb, Howard Brewington, Ed Montes and Chuck Sterling. I was informed that the 16 inch scope performed without any problems.

#### ***Moongaze, Saturday, June 3***

We had clouds, but they were thin enough so that the Moon and Jupiter could be observed. Since we just had the two targets, only Chuck Sterling's 10 inch and my ETX 125 were set up. However, we did have plenty of club member support. John McCullough, Steve Shaffer, Ed Montes and Howard Brewington all came to talk to people, so people did not have a long wait if they wanted to ask questions. Howard has a back problem, so he could not set up his scope, but it did not prevent him from supporting the event.

We were able to see the Shadows of the moons Io and Ganymede on Jupiter's cloud tops. Both moons and Callisto, were visible. Europa was behind the planet.

\* \* \*

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

June	01	20:09	Sun Sets
	01	06:43	First Quarter Moon
	02	01:42	Jupiter Multi-Moon and multi-shadow transit (Io + Europa) (20° to 37° alt)
	03	20:00	OUTREACH; MoonGaze, International Delights Café
	03	20:20	Jupiter Multi-Moon shadow transit (Io + Ganymede) (52° to 50° alt)
	09	04:08	Jupiter Multi-Moon and multi-shadow transit (Io + Europa) (02° to -39° alt)
	09	07:10	Full Moon
	10	20:58	Jupiter Multi-Moon shadow transit (Io + Ganymede) (53° to 49° alt)
	15	00:00	Saturn at opposition
	17	05:33	Last Quarter Moon
	17	20:00	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	17	23:15	Jupiter Multi-Moon shadow transit (Io + Ganymede) (39° to 13° alt)
	20	22:24	Summer Solstice
	23	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room
	23	20:31	New Moon
	26	20:04	Jupiter Multi-Moon transit (Io + Europa) (53° to 46° alt)
	30	18:51	First Quarter Moon
July	01	20:18	Sun Sets
	01	20:18	OUTREACH; MoonGaze, International Delights Café
	03	22:41	Jupiter Multi-Moon shadow transit (Io + Europa) (29° to 21° alt)
	04	00:00	Independence Day - All Day
	08	22:06	Full Moon
	15	20:00	OUTREACH; Dark Sky Observing at Leesburg Dam State Park
	16	13:26	Last Quarter Moon
	23	03:46	New Moon
	28	19:00	ASLC Monthly Meeting; Good Samaritan Society, Activities Meeting Room
	29	20:00	OUTREACH; MoonGaze, International Delights Café
	30	09:24	First Quarter Moon

Be sure to visit our web site for ASLC information: [www.aslc-nm.org](http://www.aslc-nm.org)

\* \* \*

### Announcements

1. The program for the June meeting will be a review of May's three astronomical gatherings, which includes the Texas Star Party, the Cosmic Campground, and Rusty's RV Ranch. Afterwards, we'll have our astro-imaging contest. Club members are allowed to submit one entry. Please send your electronic images to club president, Howard Brewington, at [comet\\_brewington@msn.com](mailto:comet_brewington@msn.com).
2. Road-Trip to Mount Graham, Saturday, July 15. It is not too early to sign up for this trip to tour the three observatories on Mt Graham near Safford, AZ. If you need more info, contact Mike Nuss ([nuss1419@msn.com](mailto:nuss1419@msn.com))
4. The agreement to use the facilities at Good Sam for our meeting prohibits members from bringing in ANY food or beverages, except water in a container with a screw lid. Take note: no more Starbucks or Saturn Cookies!

\* \* \*





### ***ASLC Observatory at LDSP:***

Sid Webb reported this month's program starts with "Music and Stars" at 6:30 pm with Randy Granger performing.

### ***ASLC Apparel:***

Howard had a number of apparel items with the ASLC logo available for sale after the meeting.

Gary Starkweather had information on producing large astronomy photo mosaics available.

### ***Presentation:***

This month's presentation was by John Briggs entitled "Confessions Of An Antique Telescope Collector". John is the president of the Antique Telescope Society and the owner of an extensive telescope collection. He is active in preserving the history of astronomy in the United States but specializes in telescopes and related instrumentation. John has also worked on many professional telescope projects and served as an editor for Sky & Telescope magazine.

One of John's current projects is a telescope museum and astronomy library in Magdalena, NM. His presentation was filled with great images of early telescopes and observatories and many very entertaining stories.

The May meeting of the Astronomical Society of Las Cruces concluded at 9:02 pm.

-Respectfully submitted by John McCullough, ASLC Secretary

\* \* \*

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

by Bert Stevens

Radio astronomy is an area in which most of us do not even dabble. The longer the wavelength of an electromagnetic wave, the larger the collection area has to be to reach a specific angular resolution. Our optical telescopes are big enough to give us sub-arcsecond resolution of celestial objects, but for the radio spectrum, the apertures become much wider. Even the diameter of the Earth is not enough. There have been proposals for space-based radio telescopes that are the size of the Earth's orbit.

In the early days of radio astronomy, Grote Reber was an amateur astronomer and an amateur radio operator in Wheaton, IL, near Chicago. In the mid 1930s, he learned of Karl Jansky's work in the field and was fascinated by the possibility of combining his two hobbies. Having a degree in Electrical Engineering and working at various radio companies in the Chicago area he had the skills necessary to make radio observations.

Reber had tried to join Bell Labs where Jansky was conducting his experiments, but at the height of the Great Depression, Bell Labs was not hiring anyone. By the summer of 1937, Reber decided that he would build his own radio telescope. He built a parabolic antenna about thirty feet in diameter. Like an optical meridian telescope, it could be pointed at different declinations, but it did not move in right ascension. This only allowed him to observe a target when it was straight north or south of the observing site.

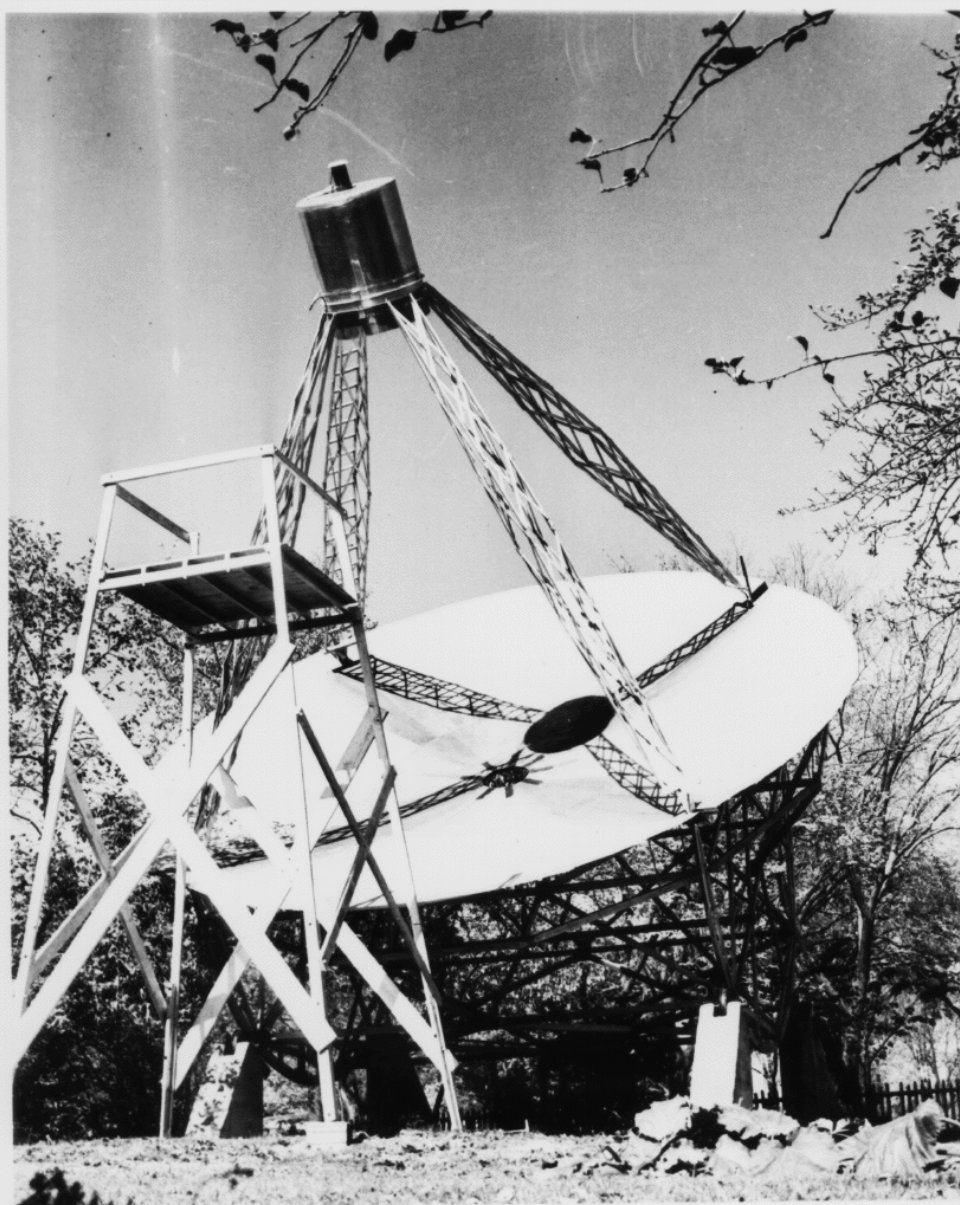


Since no one had really done much radio astronomy, he did not know at what frequency to observe the sky. The frequency is essentially the same as color in visual astronomy. He first tried toward the “blue” end at 3,300 megahertz. Finding nothing, he built a new receiver to work at a lower frequency in the “yellow” part of the spectrum at 900 megahertz. Still finding nothing, another new receiver tuned in the red part of the spectrum at 160 megahertz. There he found the sky alive with radio emissions.

He decided to use his equipment to make radio maps of the sky. For almost a decade, he was the only radio astronomer in the world. His radio maps turned up a number of radio sources that had no counterpart in the visible sky. Initially called “radio stars”, he labeled these sources with the letters of the alphabet in each constellation starting with “A”. One of the brightest of these sources was in the constellation of Cygnus, which Reber dubbed Cygnus A in 1951.

The source of the radio signals that Reber detected were somewhat of a mystery. Being in Cygnus, light from Cygnus A has to pass through a very dense mixture of gas and dust along the plane of the Milky Way, which runs right through that constellation. The dust and gas makes the objects behind it dimmer, especially those outside our galaxy. The bluer light from these objects along the Milky Way’s plane is also absorbed more strongly than the redder light. This makes these objects appear redder than they really are. These effects make it hard to determine the real characteristics of objects like Cygnus A.

Astronomers pointed their telescopes at Reber’s Cygnus A radio source and took deep images of the area. They detected an elliptical galaxy around seventeenth magnitude at the center of the source. The deep plates also showed an unusually high number of other galaxies in the same area, pointing to the possibility that Cygnus A is part of a galaxy cluster. The thick dust and gas in the plane of the Milky Way makes it hard to determine the real characteristics of these galaxies. At least four of those galaxies have been shown to belong to the Cygnus A galaxy group.



**Figure 1: First Radio Telescope**  
*Grote Reber’s meridian radio telescope was the first telescope designed to observe the sky in radio frequencies. The antenna was located in Wheaton, IL, where Reber was an electronics engineer. For almost a decade, this was the only radio telescope in the world and it produced the first radio maps of the sky, identifying such objects as Cygnus A.*

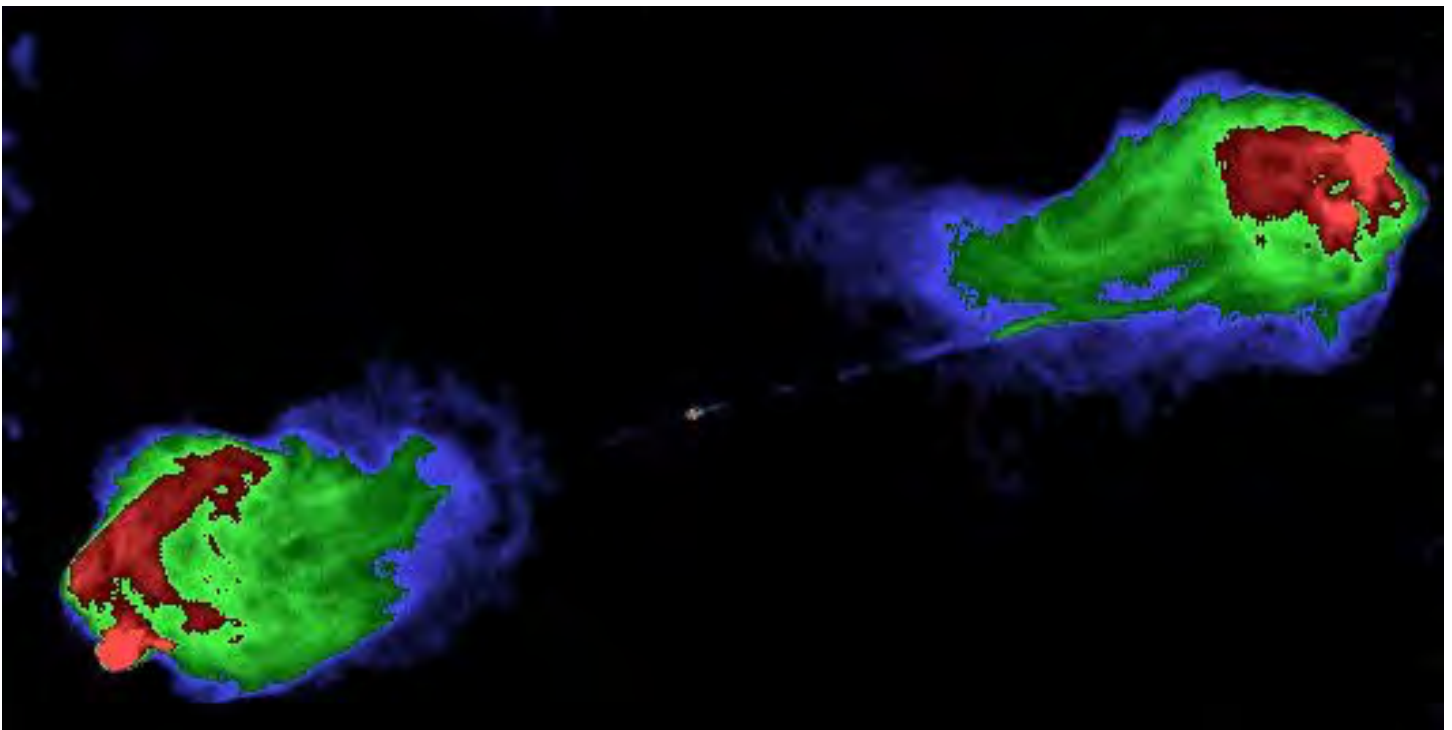


Cygnus A is an elliptical galaxy that is about 40 seconds-of-arc across. It is about the size of the Milky Way, around 130,000 light-years across at a distance of 770 million light-years. It is the largest and brightest galaxy in the Cygnus A cluster. One remarkable feature of this galaxy is the two jets shooting out in opposite directions from the core of this galaxy.

These jets shoot out from the nucleus of the galaxy. The exact method of producing the jets is uncertain, but it is an extremely energetic process occurring in an area under three light-years across, less than the distance from here to Alpha Centauri. In that area, gas is accelerated to relativistic speeds and beamed out of the core along magnetic field lines of force also generated in the core.

The jets are narrow and collimated like a beam of light travelling through Cygnus A because they have cleared the usual dust and gas out of the way early in their formation to create a huge cavity. When the jet leaves Cygnus A proper, it strikes the intergalactic medium. The narrow jets are now affected by the intergalactic magnetic field which starts to bend them. The bending of the highly energetic particles travelling at relativistic speeds causes synchrotron radiation to be generated. This is what Grote Reber picked up with his radio telescope.

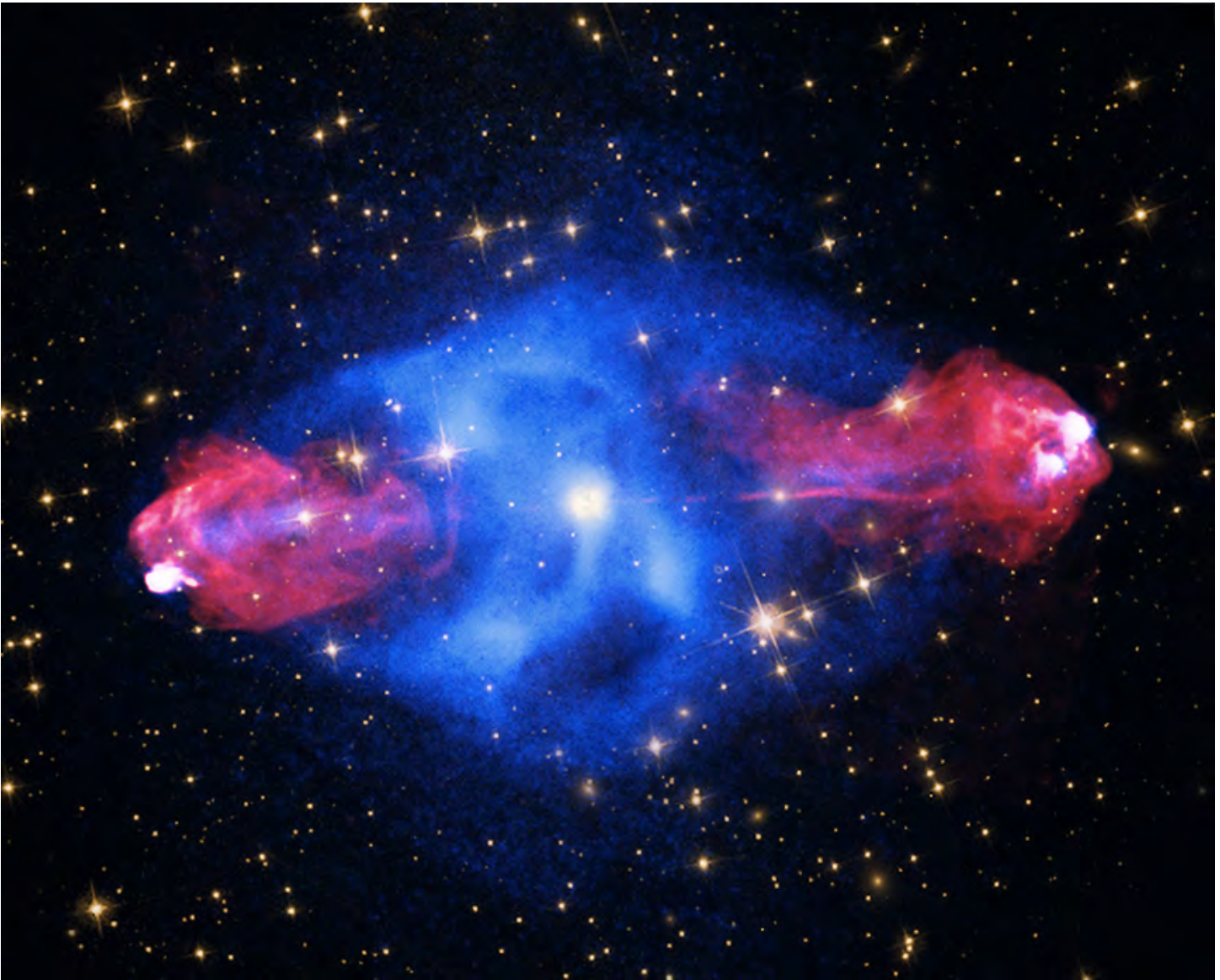
Synchrotron radiation was first detected in particle accelerators called synchrotrons. These particle accelerators accelerate the particles in a ring. As the particles travel faster, the magnetic field that keeps them in the ring is increased in synchronization with the increased kinetic energy of the particles. This allows the particles to be accelerated to near the speed of light in the same ring. Particle physicists noticed that as the particles reached relativistic speeds, they released flashes of light as the magnetic field bent their path to keep them in the ring. They dubbed these flashes synchrotron radiation.



**Figure 2: Jets of Cygnus A Imaged via Radio Telescope**

*A false-color image plotting the five-gigahertz radio emissions from Cygnus A taken in 2008. The central core spews out two jets in opposite directions. The jets themselves emit some radio signals as they flow through the galaxy. When they leave the galaxy, they strike the intergalactic medium and slow down, sending out strong synchrotron radiation in the form of radio waves.*





**Figure 3:** This is Cygnus A imaged in multiple regions of the spectrum, starting with x-ray data in blue. Cygnus A is a prodigious emitter of x-rays, probably generated by the recent absorption of another galaxy. The radio end of the spectrum is represented in red marking the lobes at the end of the jets streaming out of the nucleus. The jets and lobes extend for nearly 300,000 light-years. Visible light from a Hubble image is depicted as yellow. The surrounding star field from the Sloane Digital Sky Survey is also yellow.

The frequency of the synchrotron radiation depends on the speed of the particles and the strength of the magnetic field. Slower moving particles, but still moving at relativistic speeds, and/or weaker magnetic fields results in radio wave synchrotron radiation where faster particles and/or stronger magnetic fields can result in synchrotron radiation up into the x-ray end of the spectrum.

Where the jet strikes the intergalactic medium, a “hot spot” forms as some of the kinetic energy of the jet is transferred to the intergalactic medium, heating it up. The jet slows down and starts to scatter, forming the lobes which appear as large areas of radio radiation from the slower moving jet particles.

Cygnus A is a very active galaxy with a bright nucleus, but direct views of it are thwarted by a dense cloud of dust blocking our view of it. By observing the light reflecting from the dust near the core with the Hubble Space Telescope, astronomers were able to determine that Cygnus A's core is actually a quasar. Quasars are usually far away and it was thought that they might belong to an age long past.



**Figure 4: Jets of Cygnus A Imaged via Radio Telescope**

*A radio emission map of the central area of Cygnus A as recently observed by the VLA. The round object just left of center is the supermassive black hole at the center of the galaxy. The jets flow out to the right and left of the black hole. The new object appears to the lower right of the core.*

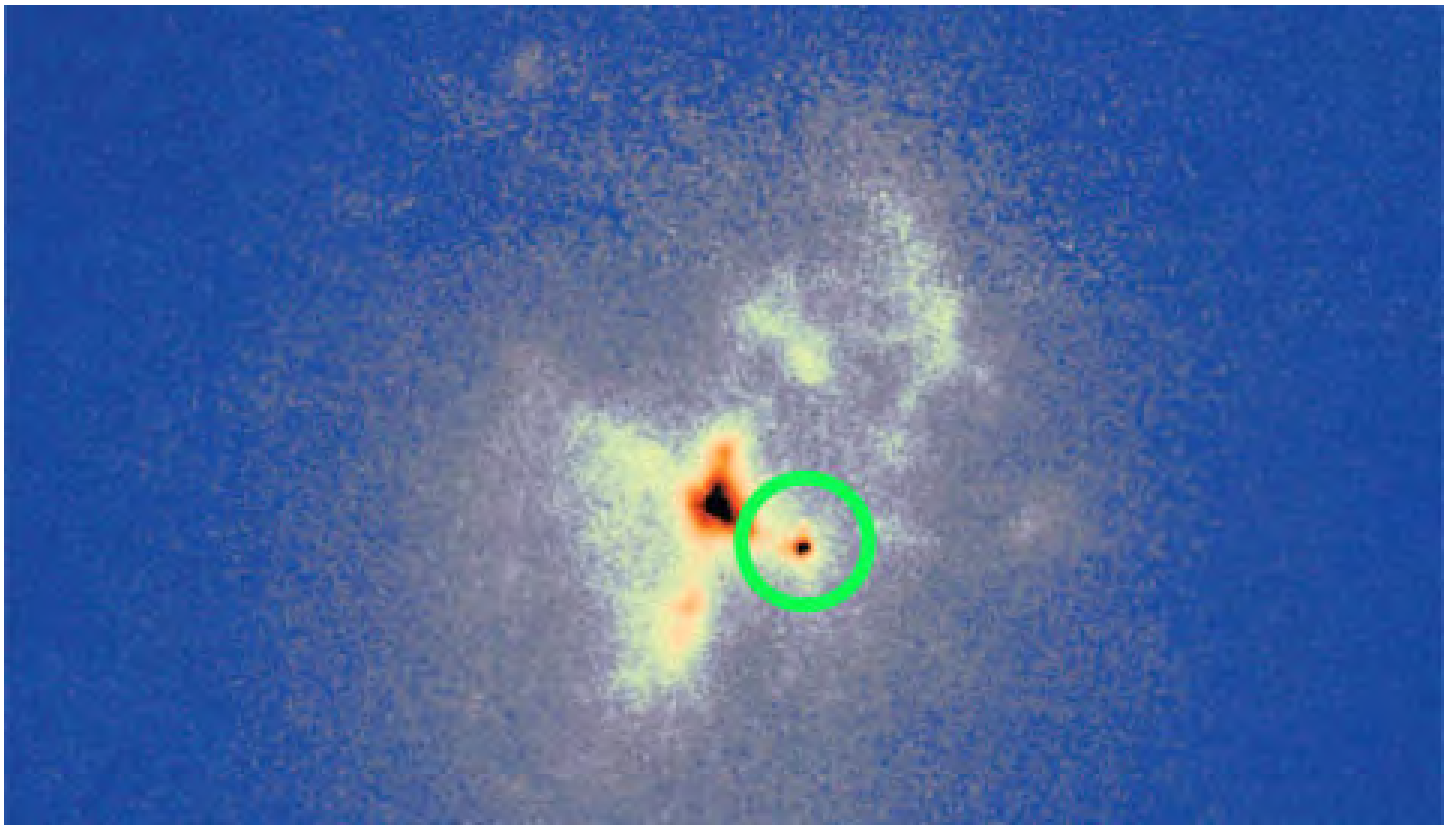
Now we find a quasar nearby and in our own era. Cygnus A provides us the possibility of a close-up study of a quasar. This may help us solve the mystery of how a quasar generates so much energy in such a small space. It is believed that a supermassive black hole accreting matter from the surrounding galaxy provides this energy. If this is so, it would appear as a point source, but Cygnus A's nucleus was discovered to be elongated in radio studies. So additional studies of the nucleus will be important to understanding how quasars work.

When the Karl G. Jansky Very Large Array (VLA) radio telescope up near Socorro, New Mexico, was upgraded, astronomers decided to take a new look at Cygnus A. The VLA had not observed Cygnus A since 1989, ending a period of intensive study of the galaxy during the 1980s. When the new observations were analyzed, astronomers were surprised to find a new object only 1,300 light-years from the core of Cygnus A.

The new object is very red, so red that it did not show up well in Hubble images. The W. M. Keck telescope consists of twin 10-meter telescopes with adaptive optics. This allowed the Keck II telescope to capture an image of the new object in 2003. The new object was found not to be a foreground object between Earth and Cygnus A, it was also not a cluster of young stars. One theory is that it is a star cluster, but of old, red, stars, accounting for its deep red color. This cluster would be the core of a very small companion galaxy that had been absorbed by Cygnus A. The absorption of another galaxy would provide new dust and gas for the supermassive black hole, which would explain why Cygnus A's black hole had "turned on".

Another theory holds that this new object may be a glance at the hot inner rim of the dusty doughnut surrounding the black hole. Yet another theory is that the new object might be another black hole from the galaxy that Cygnus A absorbed, rather than a nuclear cluster. If so, Cygnus A may be a rare galaxy, one with a binary black hole at its heart.

The fact that it is a quasar, the new object that may be a black hole and the narrow jets that are very stable over millions of years makes Cygnus A an amazing object. It is a mystery and a marvel to behold.



**Figure 5: Center of Cygnus A**

*A 2003 image of Cygnus A from the Keck II telescope shows the central area of Cygnus A. The central supermassive black hole is imbedded in the black and red region in the center. The new object (circled) is twice as bright as any supernova would be and has lasted much longer, so that was ruled out.*

\*\*\*\*



# A Tool to Help PixInsight Users with Subframe Weighting

## Alex Woronow

### Goal:

Before delving into the methods for subframe weighting, let us recall our objective. We want to combine an ensemble of images (“subframes”), each flawed to a varying, but unknown degree, to estimate the most likely unflawed (or, at least, less flawed) image that those flawed subframe images sampled. We do this by stacking the subframes, after weighting them. The subframe weights attempt to quantify the relative merit of each subframe insofar as to how well it reveals the unflawed, underlying scene. In the implementation described here, we used four measured parameters that, hopefully, speak to the merits of individual subframes. Each measured parameter has a user-defined weight and we combine the four weighted parameters to obtain a single numerical value (subframe weight) that, hopefully, quantifies the relative quality for each subframe. It’s that simple!

### Setting the Stage:

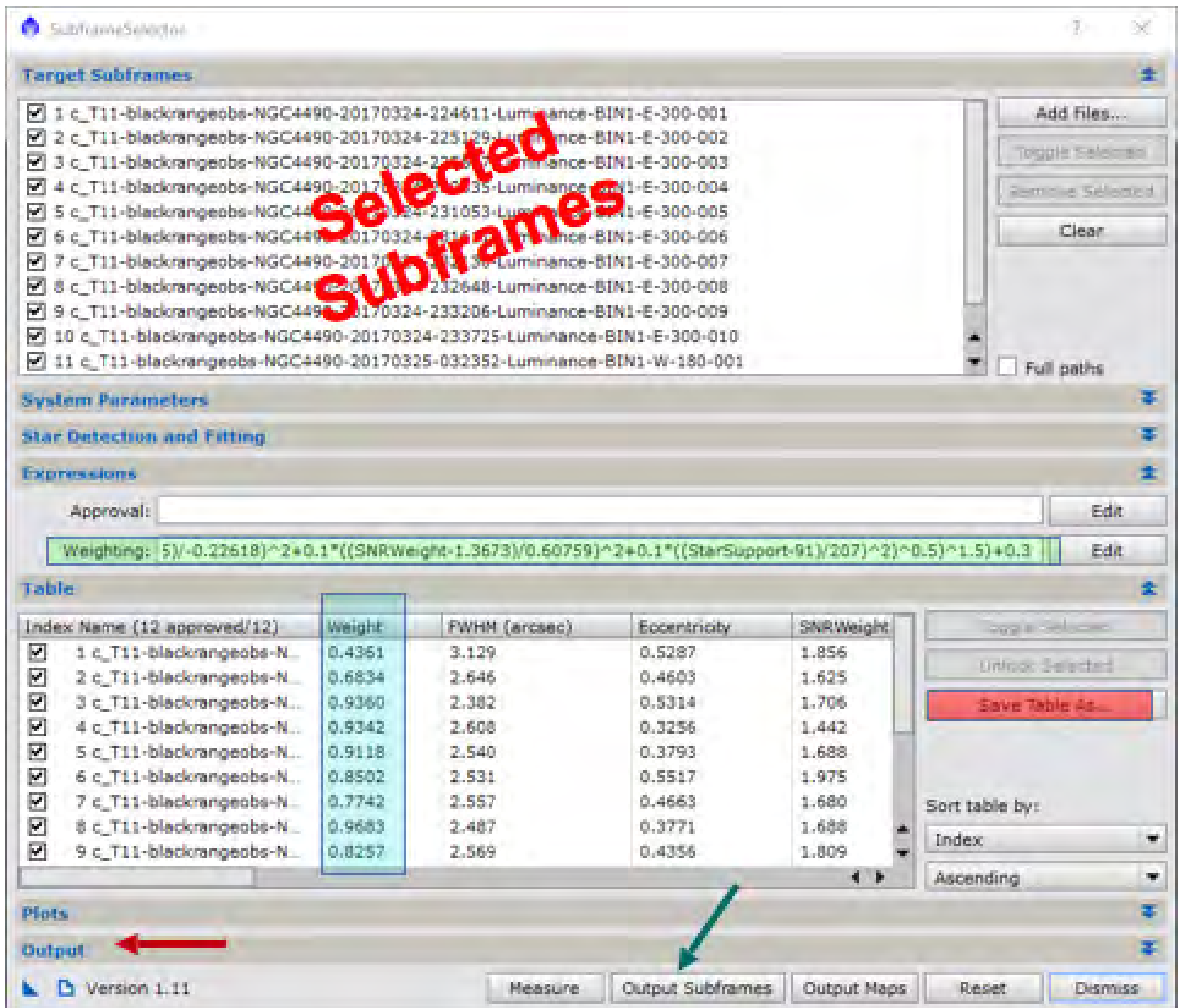
One of the scripts available in PixInsight’s standard distribution is the SubframeSelector (SS), which helps identify and eliminate faulty or inferior subframes before stacking. In the process, SS measures a number of useful parameters for every input subframe. Those measured parameters include an estimate of signal-to-noise ratio (“SNRWeight”), average star ellipticity, the number of stars present (“Star Support”), and star size (Full Width at Half Maximum—FWHM).

Examination of the numerical values of each of these measured parameters may suggest subframes to keep and subframes to discard. Beyond that, a well-constructed composite score of the parameters may serve as a subframe weight that PixInsight can use during the actual ImageIntegration process. While SubframeSelector has no built-in equation for computing composite subframe weights, it does have the ability to access a user-defined weighting-generating function. Ault (<https://pixinsight.com/forum/index.php?topic=8411.0> and references therein) has devised various subframe-weighting equations. So far, all appear to use something called an L1 measure, rather than the common L2 measure used in quality assessments involving statistical tasks such as regression analysis. The difference between the L1 and L2 norms will form part of a discussion of the underlying mathematics, farther below. In any case, my spreadsheet, “Subframe Weighting Tool” (SWT), can use either the L1 or L2 norm and presents a simple, flexible user interface. The existing spreadsheets are, in no way that I am aware, actually wrong, just not too flexible and not too general. Hopefully, SWT will remedy that.

### A Quick Look at SubframeSelector:

Under Scripts > Batch Processing lies the SubframeSelector (SS) script. We will not review the extensive capabilities of this tool, but note that it functions as a major tool for appraising the quality of individual subframes. But used alone, SS may miss flawed subframes. Blinking or examining individual subframes should always be part of the pre-stacking regimen. Ultimately, before using my Subframe Weighting Tool (SWT), pare the frames SS has loaded in its “Target Subframes” section to just the keepers, as depicted in Figure 1.

The lower “Table” panel lists all the measured parameter values (more lie to the right of those shown). The blue highlighted “Weight” equals zero for all entries when no weighting equation is specified. The green-highlighted “Weighting” field in SS receives the equation generated from SWT. When first opening SS, this field will be blank and the blue-highlighted column (Weight) will contain only zeros. To get our equation from the SWT, we first need to import some data from SS into the SWT spreadsheet. Let us cover that process next.

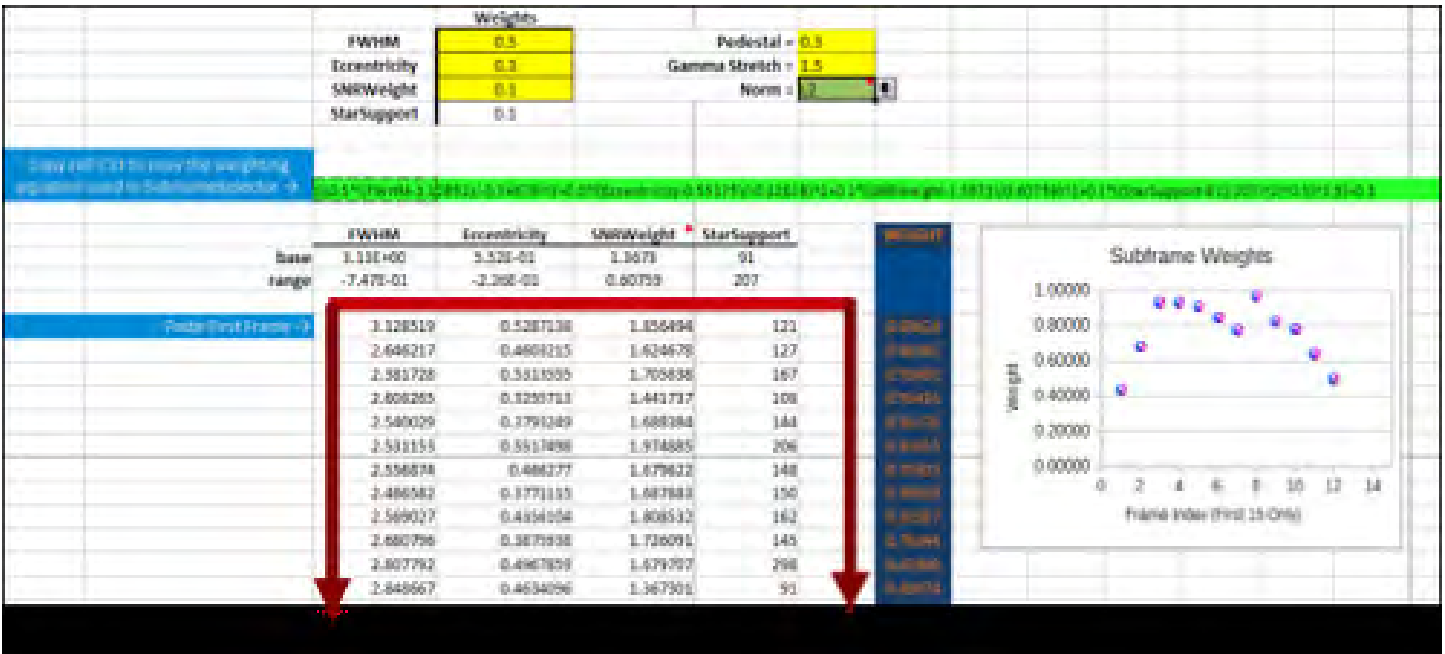


**Figure 1:** SubframeSelector with data from the Target Subframes loaded and their measured parameters displayed in the lower panel. The blue highlighted values in the lower panel comprise the subframe weights calculated from the green highlighted equation generated by the Subframe Weighting Tool.

Figure 1: SubframeSelector with data from the Target Subframes loaded and their measured parameters displayed in the lower panel. The blue highlighted values in the lower panel comprise the subframe weights calculated from the green highlighted equation generated by the Subframe Weighting Tool.

By clicking the button highlighted in red, we can export a comma-separated table (a .csv file) of the measured parameters. After doing this, we are done with SS for a while—but leave it open.

Next we open the exported file. Read the file into LibreOffice, Excel, or Open CSV (free of charge at <http://www.csvviewer.com/>) and copy and paste the data for the four measured parameters of interest (FWHM, Eccentricity, SNRWeight, and StarSupport) into the spreadsheet at the location indicated by the red arrows. See Figure 2.



**Figure 2:** The Subframe Weighting Tool. Yellow fields receive user-preferences. The data from the SubframeSelector has been pasted into the red-outlined area. The resulting weighting equation, which is pasted back into the SubframeSelector, is in the long horizontal green line.

Enter your preferences for the relative weights (more on this later) for the four measured parameters and for the Pedestal and Gamma Stretch values. (Don't panic if you do not know what the "Pedestal" and "Gamma Stretch" do. Keep reading. I'll cover that eventually.) The spreadsheet fills in everything else it needs and constructs the subframe weighting equation (in the bright green boxes) in the format expected by SS. You then copy the equation by selecting the first column of the equation in SWT and copy it to the clipboard. Then return to SS and paste the equation into the Weighting dialog area after clicking "Edit" at the right of that field.

**Ruminations on the Calculations:**

Let us briefly review the computations done to generate the subframe weights. More than one way exists to generate a subframe weight from individual measured parameters and user-assigned weights.

**Weighting Functions**

First, standardizing the individual measures parameters to a range between 0.0 and 1.0 facilitates the combining process. The equation for forming the standardized quality index is a simple linear rescaling of the measured values. For instance

$$QFWHM = ( FWHMi - FWHMworst ) / ( FWHMbest - FWHMworst ).$$

A similar equation standardizes the other parameters (Star Support, SNRWeight, Ellipticity) to the same (0, 1) range.

Then we assign a weight to each measured parameter. SWT assures that the product of the user-assigned weight and the measured-parameter value is a low number if the measured parameter value tends toward the worst in the set of subframes, and nearer to 1.0 if it tends toward the best in the set.

The next step in forming a subframe weight from the four standardized, measured parameters has a couple of alternative approaches. I have used the common, and simple, distance measure:

$$\text{Subframe } W = ( WFWHM * QFWHM^2 + WSTARSUPPORT * QSTARSUPPORT^2 + WSSRWEIGHT * QSSRWEIGHT^2 + WELLIPTICITY * QELLIPTICITY^2 )^{1/2}.$$



The W's are the user-assigned relative weights for each of the four parameters introduced above. We discuss them further in the next section.

### User-Assigned Parameter Weights

We assign individual parameter weight then combine them into a subframe weight according to the last equation. That subframe weight, we hope, quantifies how well each subframe depicts the image that a perfect, noise and distortion free, subframe would capture. The principal property of the user-assigned weights in the above equation is that they sum to 1.0. If all the weights were equal (0.25, in this case), then the underlying assertion is that all four parameters have an equal say in determining the best, worst, and other subframes' quality. Obviously, values less than 0.25 indicate that the user perceives that the corresponding parameter has less to say about subframe quality than one with a value greater than 0.25. These weights are strictly relative, and assigned according to the user's knowledge and perceptions. I know of no other way to do it.

The relative importance of each measured parameter in determining the subframe weight depends of many factors. First, it may depend on the target. A small degree of star ellipticity may have elevated importance when imaging a galaxy and trying to resolve its internal structure, but star ellipticity probably has far less importance for imaging a fast-moving comet. Additionally, the intended use of the image (photometric study versus pretty picture, say) also may affect the relative values of the user-assigned parameter weights. Sometimes one measured parameter varies minimally among subframes, and giving it a large role in determining subframe quality influences very little in the final stack. And so on.... The user has final say in the parameter weightings, and tries to assure that the computed subframe weights reflect, at least, the ordering of subframes with regards to their accuracy in portraying the underlying scene.

### Quantifying the Subframe Weights

Let us look more closely about how to computationally combine the individual weighted parameters into a single subframe weight. Alternatives exist (surprised?). The two most common approaches use the L1 norm or the L2 norm. Of those choices, the L2 norm has the better statistical justification in many situations and the widest use. First, let us describe the L1 versus L2 norm through an irrelevant example. If we have two locations, A and B, in Manhattan, NY, and wish to get from A to B, there are a couple of alternative paths. If we take a taxi cab on the grid of streets, then the distance traveled equals the sum of the E-W street segments plus the sum of the N-S street segments. This approach mimics the L1-norm approach. That is,

$$L1 \text{ Distance} = \Sigma |(EW)| + \Sigma |(NS)|$$

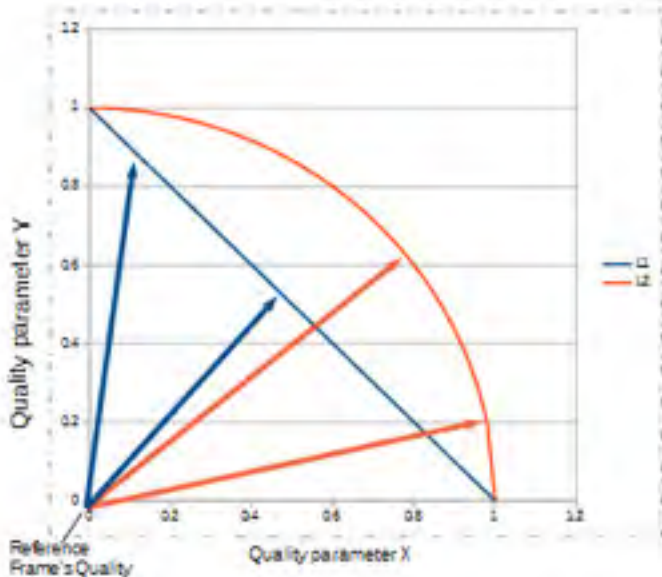
For this reason, the L1 norm is often referred to as the "Manhattan" or "Taxi" norm.

However, what if we have access to a helicopter? Then the distance between A and B is the straight-line distance or hypotenuse of a triangle:

$$L2 \text{ Distance} = \{ [\Sigma(EW)]^2 + [\Sigma(NS)]^2 \}^{1/2}.$$

(At this point, we have ignored the user-assigned weights.) With these facts in mind, we must make the somewhat arbitrary decision whether we want to combine our weighted measured parameters according to the first equation (L1 norm) or the second (L2 norm). One more insight may be of some help. Presume we have two measured parameters that we have decided to weight equally for computing subframe weights. In Figure 3, we plot the normalized values of two arbitrary parameters X and Y as the axis of a graph. We calculate the subframe weights by the L1 or L2 norm. In Figure 3, all subframes with the combinations of parameters X and Y that lie on the blue line, by definition, have equal dissimilarities to the actual scene that was imaged according to the L1 norm. On the other hand, all subframes that lie on the orange circle share an equal dissimilarity to the actual scene that was imaged, according to the L2 norm. Which should we prefer? There is no right or wrong choice for this problem, but sta-

tistical traditions and many well-studied applications suggest that solutions using the L2 norm preform as well or better than those using the L1 norm in almost all cases. But, for our problem, it may make little difference, given that user-assigned parameter weights are pretty much arbitrary in magnitude, if not also in their rank ordering.



**Figure 3:** A visualization of the difference between an L1 norm and an L2 norm. Subframe Weighting Tool can output a subframe-weighting equation that uses either norm.

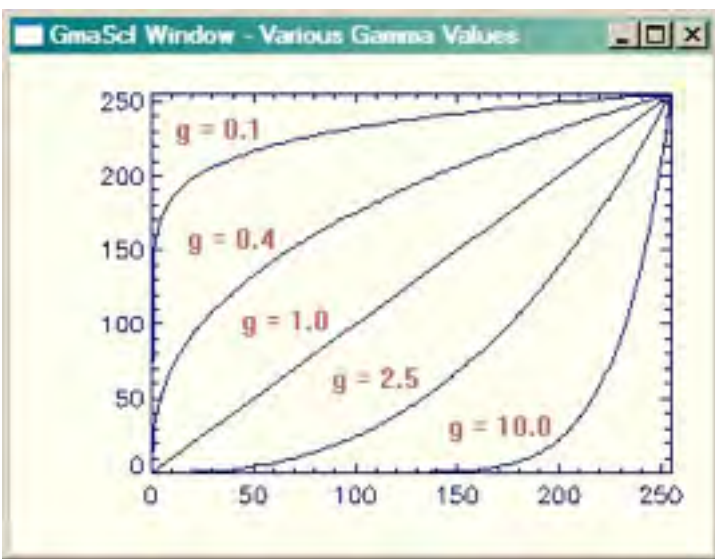
### Gamma Stretching the Subframe Weights

Once the user has assigned parameter weights, and we have applied an L1 or L2 norm, SWT calculates a subframe weight for each subframe. We then can manipulate the subframe weights to better reflect our impressions about their best distribution of values. For example, we may feel that most of the current subframe weights, overall, appear good, but some sub-par subframes are emphasized too greatly. In that case we could “stretch” intermediate values toward a higher weight while leaving behind a few of the sub-par frames. A

simple function for doing this is the “gamma stretching function,” akin to a gamma adjustment on your TV or monitor. You also may recognize it as one of the stretching options very commonly encountered in stretching astro images. The equation

$$w1 = (w0)^\gamma$$

imposes a very simple gamma stretch. That is, the new weight equals this function of the original weight, where the exponent “ $\gamma$ ” determines the strength of the stretch. If  $\gamma = 1.0$  no stretching occurs. Figure 4 illustrates the relation between the input weight and the output weight.



**Figure 4:** Gamma stretch as a function of the value of gamma. ([http://www.idlcoyote.com/ip\\_tips/xstretch.php](http://www.idlcoyote.com/ip_tips/xstretch.php))

### A Pedestal for Subframe Weights

Again, in analogy with astro images, we can impose a pedestal on subframe weights. But in this case our motivation is to adjust the range of weight so that the best frames lie near a weight of 1.0. That is, we may adjust the pedestal to position the ensemble of weights vertically. Under most conditions, I suspect, this has little noticeable effect on the final stacked results—nonetheless, I have provided the mechanism to do it. If, after stretching and applying a pedestal, some parameter weight approaches a value of 1.0, that does not imply that the associated

subframe nearly perfectly captures the true scene. It simply means that the corresponding subframe is the best subframe in the set.

(For consistency purposes, the pedestal gets applied after the stretching, although most users would not notice or care about this detail.)

### Further User Considerations:

Subframes gathered together for weighting should be a homogeneous lot, both in terms of target and filter. However, grouping across exposure time is proper. Most of the user interactions with PixInsight and my Subframe Weight Tool spreadsheet are enumerated at the top of SWT spreadsheet and repeated here.

- Input your preferred parameter weights for the three yellow-highlighted fields under “Weights.” (all weights must be 0 or positive and sum to 1). The weight for the final box will be automatically calculated.
  - If a parameter’s span of values is small, consider down-weighting that parameter.
- Run the SubframeSelector scrip of PixInsight, loading the subframes of interest.
- Export the table to a .csv file and read that file into a LibreOffice page or open it with the free program CVS Reader (<http://www.csvviewer.com/>) or by other means.
- Copy the four measured parameters being used by Subframe Weighting Tool into the input columns (see delineated region in Figure 2).
  - Before pasting the measured-parameter values into SWT, REMOVE unapproved frames or frames you do not intend to use in the final image integration.
  - Adjust the entries for Pedestal and Gamma Stretch as desired.
  - The graph can help monitor the effects of changing these user inputs.
  - The bright-green field in SWT is the weight equation to be pasted into SS—so do that.
  - Open the SS pull-down menu area “Output” (Figure 1, red arrow) and fill in the output-folder path and, very importantly, assign a keyword in the “Weight Keyword” field!
  - Click the “Output Subframes” button (Figure 1, green arrow) and all subframes will be written to the location specified, and their FITS headers will contain the specified Weight Keyword and the subframe weights we have worked so hard to calculate.
  - In PixInsight, to stack the frames, we invoke the ImageIntegration process and go to the pull-down menu “Image Integration.” Then under Weights, select FITS Keyword and fill in the name for the keyword you assigned above.

The stacking of subframes will reflect the weights you have generated. (Note: If one of the user inputs causes a violation, some spreadsheet field likely will turn red, although all contingencies are not covered. Also the L1 option is always tinged slightly red to remind the user to consider the L2 norm instead.)

Transportability:

I do not know if recent versions of Microsoft Excel can import the equations in the SWT spreadsheet properly. Older versions of Excel simply ignore equations—bigly sad! However LibreOffice should export to a variety of Excel-formats (using the Save As dialog). Google Sheets, as gleaned from its reviews, will not import the LibreOffice spreadsheet either. OpenOffice probably will work, because it is a progenitor of LibreOffice. In any case, LibreOffice is free, and pretty much a total-featured alternative to the ever-increasingly costly Microsoft Office. LibreOffice is cross-platform too: Try it...you may like it!

Alex Woronow

**Ed Note** - *The Subframe Weighting Tool is available as an Excel spreadsheet. If you would like a copy, send me an email at: [turnerc@stellanova.com](mailto:turnerc@stellanova.com) and I will send it to you.*

\* \* \* \*



## *Photo of the Month*



**The Trio in Leo:** The Leo triplet includes three large interacting spiral galaxies in the constellation Leo, plus a few unrelated, very distant ones in the background. NGC 3628 is at the bottom, M66 upper right, and M65 to the left. Their estimated distance from us is 30 million light years.

This shot was taken from our back yard in Las Cruces, NM using a Canon 60Da camera with a MPCC (Multi-Purpose Coma Corrector) and an LPS-P1 (Light Pollution Suppression filter) on an Astro Tech 8-inch f/4 Imaging Newtonian on a Celestron CGE mount. Autoguiding was done using PHDGuide 2.6.3, an Orion ED80 refractor, and a Meade DSI-Pro-I camera. I shot 40 60-second images at ISO1600 using Images Plus Camera Control. These were processed in Images Plus 6.05 and Photoshop CS4 to produce the final image above.

Chuck Sterling, Las Cruces, NM

**Photo of the Month**



**NGC 6144:** This is a globular cluster in Scorpius. It is mag 9.0 and about 29 Kly distant. This shot was taken at Covered Bridge Observatory in San Lorenzo, NM. Exposure was 60 x 1m with a C-14HD Hyperstar and a QHY-183 camera.

The bright star just off the frame is Antares and the nebulosity is also associated with Antares.

Chris Brownewell, San Lorenzo, NM



**Photo of the Month**



**Omega Centauri.  
By John Gilkison.  
Shot this at Caballo  
Lake S P on the 20th  
of May. Headlights  
illuminated the cliff  
for me. 30 seconds at  
F/2 at 1600 ISO.**

*I was doing the laser guided tour of the constellation when I pointed out to the group that Gamma Hydra and Iota Centauri pointed right to Omega Centaurus the great globular cluster in the sky. I told them it was behind the trees but would appear in that gap in the trees in 20 or 30 minutes. When it did there were only 2 people left to witness me taking the picture and who got to observe the globular in the telescope.*



**Photo of the Month**



**Image from trip to Rodeo attached, plum out of relevant poems The dark skies of SW New Mexico lend one to chase reflection nebulas which are difficult to obtain in Las Cruces.**

**Sharpless 2-73 is quite faint and is considered mostly interstellar dust with little HII contribution although it is in the Sharpless catalog of HII objects.**

**Sh 2-73 is located in the constellation Hercules with a high galactic latitude of 45°; therefore, the integrated light of the galaxy illuminates the nebula.**

**Telescope     Takahashi Epsilon  
Camera        FLI ML 161200  
Filters        RGB 1x1 12x3min / Lum 12x 5min  
Processing:   CCDstack & PS 6**

**Date/Location     Rodeo, NM: May 24, 2017  
Copyright John Kutney**



**Photo of the Month**



**M82** (LHaRGB): first processing. DSW 14.5" RCOS; Sbig 16803 with AO. about 4hrs each RGB, about 5hrs Ha, and 3.5hrs L. This has been aggressively cropped. All processing (including calibrating lights) done in PI. I used my method (I'll post it soon) for separating the Ha emission line from the red background to produce an "Ha-enhanced" red, with 7::1 Ha to background.

The red area in M82 is a "star burst." M81 has swept the Ha gas from the disk and concentrated it in M82's central region. This is where active star formation is now occurring...hence the strong reds. The disk has virtually no star formation currently, and is bluish by this deficit. (At least that's the story I learned.)

Alex Woronow



**Photo of the Month**



**OBJECT** IC 2169 (blue reflection nebula) and surroundings **Distance: 2,600 light years**  
**Telescope** Takahashi FS-60C @ f/6.2 **Mount** Takahashi EM200 Temma II  
**Camera** QSI 540wsg @ -15C  
**Filters** Astrodon Astrodon Tru-Balance I-Series LRGB Gen 2  
**Guider** SX Lodestar  
**Settings:** 9x5min L (bin1x1); 2x5min ea RGB (bin2x2); AstroArt5, CS4 (slightly cropped, 10xdarks/flats/fdarks/bias)  
**Date/Location** 29 January 2017 - Las Cruces, NM  
**This image is LRGB**  
**Copyright** Jeffrey O. Johnson

A Dark Day in the Revolution  
by Lars D. H. Hedbor



*Total eclipse of the Sun. [http://upload.wikimedia.org/wikipedia/commons/2/23/Total\\_solar\\_eclipse\\_2006-04-29.JPG](http://upload.wikimedia.org/wikipedia/commons/2/23/Total_solar_eclipse_2006-04-29.JPG)*

In the tumult of the military revolution that forms the backdrop of most study of the War of Independence, it's easy to forget that the sciences were undergoing a parallel revolution. We've all heard about Benjamin Franklin's experiments along the far frontiers of knowledge of electricity, even if the popular conception of them is somewhat skewed. "Natural philosophy," as the pursuit of what we would today identify as science, consumed a great deal of attention and ink on both sides of the Atlantic. Right through the era of the Revolution every year brought important new discoveries and observations.

While many avenues of scientific exploration must be shifted to accommodate the vagaries of current events, astronomy, in some cases, cannot be delayed or displaced, lest the opportunity for important observations be missed completely. Eclipses fall into this latter category, presenting very different phenomena depending upon whether the observer is well-situated or placed less than ideally.

The total solar eclipse of June 24, 1778, which was seen in many parts of the nascent United States, excited the imagination of many natural philosophers. A Spanish sailor, Antonio de Ulloa, presented to the Royal Society of London a description of the Sun's corona: "Out of this luminous circle there issued forth rays of light, which reached to the distance of a diameter of the Moon, sometimes more, sometimes less..."

As the date of the next total solar eclipse neared, in October of 1780, Samuel Williams of Harvard University was determined to observe it. Inconveniently, his calculations showed that it would be best observed along the shores



of modern-day Maine -- at the time tenuously held by a British garrison. No matter how sweeping the events that might convulse human affairs, the orbits of the planets do not yield to our petty squabbles.

However, Williams convinced the Massachusetts Speaker of the House, John Hancock (of the famed signature on the Declaration of Independence) to send a letter to the British commanders in the area, asking for safe passage to the site, as a "Friend of Science." The British Colonel Campbell at Penobscot gave the permission for a strictly limited stay at the chosen location. The location Williams had asked for was worryingly nearby to his recently-besieged fortification there, and he did not want to take any chances with further American skullduggery.

After securing passage and wheedling precious supplies out of the Massachusetts government, Williams assembled a collection of the most advanced observational instruments available. All appeared to be in place for an American natural philosopher to make an important contribution to the advancement of astronomy, as well as the first detailed scientific observation of a total solar eclipse in North America.

The expedition arrived early and secured grudging permission to land and begin their preparations before the date originally specified by Campbell. He refused to let them onto the mainland, instead confining them to a small island off the shore where his garrison stood. Williams calculated that the location was within the area he'd planned to attempt, so they set up camp and arrayed their instruments to best take advantage of the natural spectacle to come.

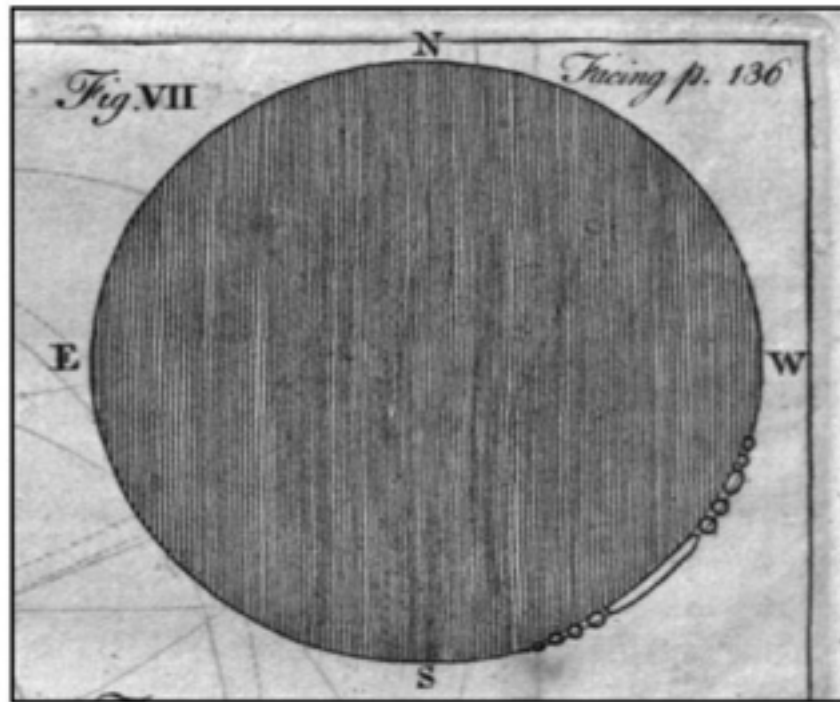
Among other things, they brought a precision compass, astronomical octant, telescopes, and perhaps most critically, a high-quality clock to time the different events of the eclipse for refinement of the exact longitude of the site. This was a matter of wide usefulness to naval interests of all nations, and the chief practical objective of the expedition.

For readers who have experienced a total solar eclipse, Williams' description of the event will doubtless bring a thrill of remembrance; the rest will have to imagine it from his words (and doubtless add it to their bucket lists):

*“Immediately after the last observation the sun's limb became so small as to appear like a circular thread or rather like a very fine horn. Both the ends lost their acuteness and seemed to break off in the form of small drops or stars; some of which were round and others of an oblong figure They would separate to a small distance: Some would appear to run together again and others diminish until they wholly disappeared. Finding it very difficult to measure the lucid part any longer I observed again in the larger telescope looking out for the total immersion. After viewing the sun's limb about a minute I found almost the whole of it thus broken or separated in drops a small part only in the middle remaining connected...*

*From the beginning of the eclipse unto the time of the greatest obscuration the colour and appearance of the sky was gradually changing from an azure blue to a more dark or dusky colour until it bore the appearance and gloom of night. The degree of darkness was greater than was to be expected considering the sun was not wholly obscured... Objects at a small distance appeared confused and we were obliged to make use of candles to count our clock. But as soon as the greatest obscuration was past it was universally remarked that the increase of the light was much more rapid than that of the darkness had been. As the darkness increased a chill and dampness were very sensibly felt... To this we may add so unusual a darkness dampness and chill in the midst of day seemed to spread a general amazement among all sorts of animals: Nor could we ourselves observe such unusual phenomena without some disagreeable feelings. “*





*Williams' diagram of the eclipse*

The event being over, the expedition packed up and left in accordance with Campbell's orders, though Williams wrote later that he wished for the opportunity to amass additional observations to improve the accuracy of his calculations. Regardless, he prepared his triumphant report to the American Academy of Arts and Sciences. He exulted that they had the pleasure of "achieving their objectives," recording sufficient data to very accurately calculate the exact longitude and latitude at which their observing site had been located.

However, even in the moment of observing this natural marvel, Williams' excitement was tempered by the realization that their location, constrained as it had been by military considerations, had missed the area of actual totality by a mere handful of miles: "The longitude of the place of our observation agrees very well with what we had supposed in our calculations. But the latitude is near half a degree less than what the maps of that part of the country had led us to expect. On this account our situation, instead of falling within the limits of the total darkness, proved to be very near the southern extremity."

Despite his disappointment, Williams' contributions to the advancement of science could have been greater, had he recognized the phenomenon he described and sketched as being a new and original observation. The "small drops or stars" he described were recognized by a later (British) scientist, Francis Baily, as being the places where the sliver of the Sun's light at its edge is being interrupted by the jagged peaks of mountains along the edge of the Moon. "Baily's Beads," as this phenomenon has become known, might have been called "Williams' Drops" instead, had he pursued this observation more acutely.

It's easy enough to overlook the broad and chaotic ferment of ideas outside of the field of political philosophy that formed the backdrop to the Revolution. It is remarkable to learn that even in the midst of the armed struggle, scientific advancement was considered by both sides important enough to take priority over the more ephemeral concerns of politics and military supremacy. Even as the course of history was being decided on the battlefields, this history of ideas and knowledge continued to unfold, only occasionally being hindered by mundane events.

Lars D. H. Hedbor is an advanced amateur astronomer, serving on the Board of Directors of the Oregon Star Party, and a novelist of the American Revolution. His book *The Darkness: Tales From a Revolu-*

tion – Maine centers on the events in the coastal Maine community where the Williams Expedition traveled to observe the 1780 eclipse, and is available in paperback and ebook through all major online retailers.

\* *de Ulloa, Don Antonio, and S. Horsley. "Observations on the Total (with Duration) and Annular Eclipse of the Sun, Taken on the 24th of June, 1778, on Board the Espagne, Being the Admiral's Ship of the Fleet of New Spain, in the Passage from the Azores towards Cape St. Vincent's. By Don Antonio Ulloa, F. R. S. Commander of the Said Squadron; Communicated by Samuel Horsley, LL.D. F. R. S."* *Philosophical Transactions of the Royal Society of London* 69: 105-119. <http://rstl.royalsocietypublishing.org/content/69/105.full.pdf+html> (accessed May 17, 2014).

\* *Baxter, James Phinney. The Baxter manuscripts,. Portland, Maine: Maine Historical Society, 1914.* <http://books.google.com/books?id=d8EMAAAYAAJ> (accessed May 17, 2014).

\* *Rothschild, Robert Friend. Two brides for Apollo: the life of Samuel Williams (1743-1817). New York: IUniverse, 2009.*

\* *ibid.*

\* *Memoirs of the American Academy of Arts and Sciences to the end of the year M, DCC, LXXXIII. Volume I. Boston: Printed by Adams and Nourse, in Court-Street, 1785.* <http://books.google.com/books?id=OrwAAAAAYAAJ> (accessed May 17, 2014).

\* *ibid, via Rothschild, Robert Friend. Two brides for Apollo: the life of Samuel Williams (1743-1817). New York: IUniverse, 2009.*

\* *Baily, Francis. "On a Remarkable Phenomenon that occurs in Total and Annular Eclipses of the Sun."* *Memoirs of the Royal Astronomical Society* 10: 1-42. <http://books.google.com/books?id=I21aAAAAAYAAJ> (accessed May 17, 2014).