

CACHE VALLEY CLEAR SKIES



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PRESIDENT'S CORNER **Dale Hooper**

We are now into summer and the nights will now begin to get a bit longer. On June 20th we had our annual club potluck dinner and solar party. If you weren't able to attend it you were missed. For July we currently only have one scheduled club event, but watch your email in case there are any added star parties.

On July 18th we have a public star party planned for the Newton Reservoir parking lot (Lat 41.898568, Long: -111.973790). This star party will be in support of the Utah Division of Outdoor Recreation (UDOR) Every Kid Outdoors (EKO) Adventure Challenge, and will allow kids to complete their Starry Skies challenge. We are also planning to have a club member only star party or two. Thus far, the most likely dates are still August 15th and/or August 22nd. This will also likely be held at the Newton Reservoir parking lot. Watch for additional details.

I wanted to bring you into a project that I have been working on for a long time. Way back in 1999 I built an initial radio telescope from a repurposed ten-foot diameter C Band satellite dish. If you'd like more details about my initial efforts, you can find a couple articles I wrote called, "My Experiences Putting Together A Radio Telescope", parts 1 and 2. These articles can be found at <https://physics.weber.edu/palen/oas/newsletter/mar01.htm> and <https://physics.weber.edu/palen/oas/newsletter/apr01.htm>. The articles are in the March and April 2001 Ogden Astronomical Society Star Diagonal newsletter. I'm not going to delve too deeply into many of the concepts related to radio astronomy in this article. If you'd like a better understanding of the basic concepts of radio astronomy, you can find a fantastic primer created by NASA's JPL at:

https://cdn.preterhuman.net/texts/science_and_technology/astromy_and_astrophysics/Basics%20of%20Radio%20Astronomy%20for%20the%20Goldstone-Apple%20Valley%20Radio%20Telescope.pdf, you can also find this as an online presentation at

<https://astronomyonline.org/Science/RadioAstronomy.asp>

However, there is one key concept that is important to understand and that is, what is meant by a hydrogen line telescope? Neutral hydrogen has one proton and one electron. As shown in the figure below, electrons in a hydrogen

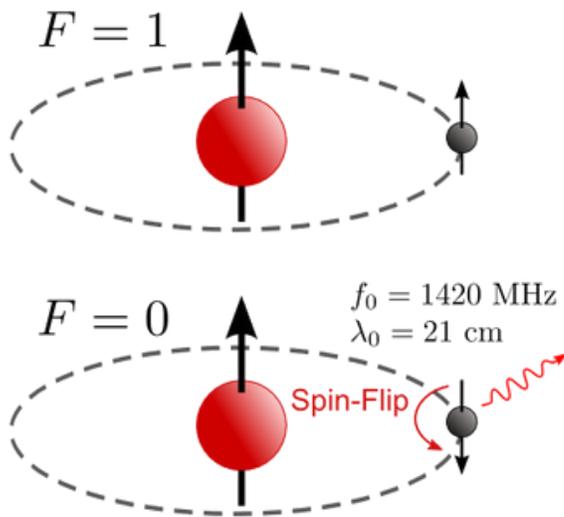


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atom can spin either parallel to or anti-parallel to the spin of the proton. Collisions between atoms can cause a flip of the electron into the higher energy parallel state. The spontaneous spin-flip back to the lower energy (anti-parallel) state causes a photon to be emitted at 1420.405 MHz which is in the radio frequency range. This state change is rare, but there is a LOT of hydrogen in the galaxy and in the universe and these objects composed of hydrogen do some very interesting things. So, radio telescopes can be built that are tuned to listen around this frequency which is called the hydrogen line.



A hydrogen atom with proton and electron spins aligned (top) undergoes a flip of the electron spin, resulting in emission of a photon with a 21 cm wavelength (bottom). Open-source Wikimedia diagram

For anyone that has an interest in getting started in hydrogen line radio astronomy like I am doing, I would suggest checking out the Scope-In-A-Box kit from the Society of Amateur Radio Astronomers. This includes essentially everything you need to get started in radio astronomy except the computer. You can purchase this at: <https://www.radio-astronomy.org/store/projects/scope-in-a-box>. You can also find more information about what this does at: <https://www.rtl-sdr.com/cheap-and-easy-hydrogen-line-radio-astronomy-with-a-rtl-sdr-wifi-parabolic-grid-dish-1na-and-sdrsharp/>

My initial radio telescope could only be moved along the meridian and I would have to wait for objects to drift across the field of view. When I retired, I decided to upgrade my radio telescope so that it would be fully steerable and support tracking in a manner similar to any other goto telescope. This project became much more frustrating, much more time consuming and much more expensive than initially planned. Most of the new

hardware came from the Netherlands and the shipping costs were very exorbitant because the company didn't have a United States presence and they were unwilling to ship things using low cost (read slow) options.

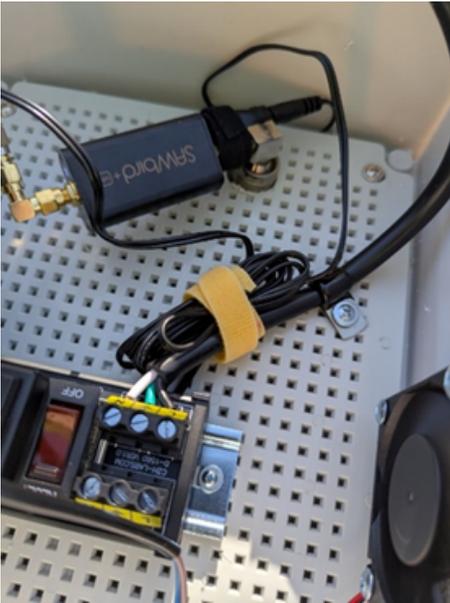
After I had everything assembled, I could get the dish to move in any direction but it would not display the elevation or azimuth values, so there was no way to determine where it was pointed. This was totally useless for a goto system. The company I purchased things from was not very helpful and communication was very slow. The problem likely was that I had some issues with the connectors I had to solder onto the control cable. But to get it to work took a lot of diagnostic help from Randy Jost. I had them send me a fully assembled diagnostic cable and I ultimately ended up replacing the controller and a pulse counting board. But I finally had a working system.

I have many thoughts about what I would do differently if starting over but I will spare you the details for now.

The electronics of the radio telescope itself (as a receiver) are actually much simpler than what I used when I first started. Connected to the dish's feedhorn is a Low Noise Amplifier (LNA) (see the left figure below) which has much better noise characteristics than the original one I used and it is significantly less expensive. The LNA is mounted as close as possible to the feedhorn so that it can amplify the very weak signals received from space. The LNA is connected to a low loss cable which runs into the observatory.

Cont'd on pg 3

Star Party		Club Meetings	
• July 10 th	Summer Citizens	Details to follow	
• July 18 th	Newton Reservoir	9:30pm	Club meetings will resume in September
• Aug 15 th or 22 nd	Newton Reservoir	9:00pm Club only	



Low Noise Amplifier (LNA) near top of image. This is a NooElec Sawbird+ H1 LNA.



NooElec SmarTee SDR shown plugged into USB3 port of the computer

Inside the observatory the other end of the cable is connected to a Software Defined Radio (SDR). SDR's are fairly simple devices. The SDR contains hardware to convert the radio frequency signal to an analog signal, filter it to an intermediate frequency and an Analog to Digital Converter (ADC) which converts it to a digital signal that is then fed to the computer. All of the digital signal processing is completed by software on the computer.

The SDR that I am using (NooElec SmarTee) has an SMA type input connector and the digital output is over a USB3 connector (see SDR figure). Wavelengths in the radio frequencies are much longer than those in the visible light range. Because of this even though my dish is ten feet in diameter, the resolution of a single small radio telescope is MUCH less than the smallest telescope in the visible range. The beamwidth for my radio telescope at the hydrogen line frequency is four degrees! This means that to resolve separate sources they need to be at least four degrees apart in the sky.

A radio telescope like mine is not used for creating images of the sky (at least not in a single observation). Instead, the SDR is used to quickly sample a range of data centered on the hydrogen line. The SDR software is used to perform the mainstay of digital signal processing known as the Fast Fourier Transform (FFT) to determine the strength of the signal at the various frequencies in the signal sample. The software can also be used to determine the total power of the signal in the sampled area. For most of what I am doing I'm using frequency strength data. This allows us to do spectroscopy of the signal sample which is a very powerful tool, even for a small radio telescope like mine.

The SDR software I use called SDRAngel is a free and open-source application. It is very robust and supports a very wide variety of SDR applications. For my purposes there are a number of key features provided by this software:

- It supports a variety of SDR hardware
- Natively supports a rotator controller capability which uses the protocol of the rotators that I am using so that sources can be tracked
- Provides a star tracker feature which allows for tracking many specific objects as well as any other objects based on Right Ascension and Declination. Galactic longitude and latitude values can also be used. The computed values are translated to altitude and azimuth and sent to the rotator controller
- It provides a SkyMap feature which allows visualization of the objects from multiple online catalogs and allows for object selection from the catalogs. It is also able to interface with Stellarium. The location values are translated to altitude and azimuth and sent to the rotator controller
- It has great support for radio astronomy including signal integration (similar to stacking), display of the spectra and total power information, support for calibration, saving and loading data and many other tools.

SDRangel has so many tools and features so I was initially somewhat intimidated when I first started using it. But the tools are very well integrated and seem to work pretty reliably. Its available for either Windows or Linux and I am running it on a Linux Ubuntu 24.04 desktop system.

When I was diagnosing things, I started with some software known as ezRA Radio Astronomy, it has some really nice features for getting started and automatically configures the most common SDR receivers. This really helps you be able to tell if you are reasonably seeing a Hydrogen Line signal. However, it has no rotator support.



Bird bath look in stowed position. This prevents water from leaking into the fan vents of the electrical box

A hydrogen line radio telescope can be used to study the spiral structure and rotation curve of our galaxy. We can also detect such things as massive star formation regions, supernova remnants, Sgr A* and active galactic nuclei. Because we can do spectroscopy, we can determine the radial (line of sight) velocity of the source, i.e. is it redshifted (receding) or blue shifted (approaching us). We can also determine the relative strength of the source.

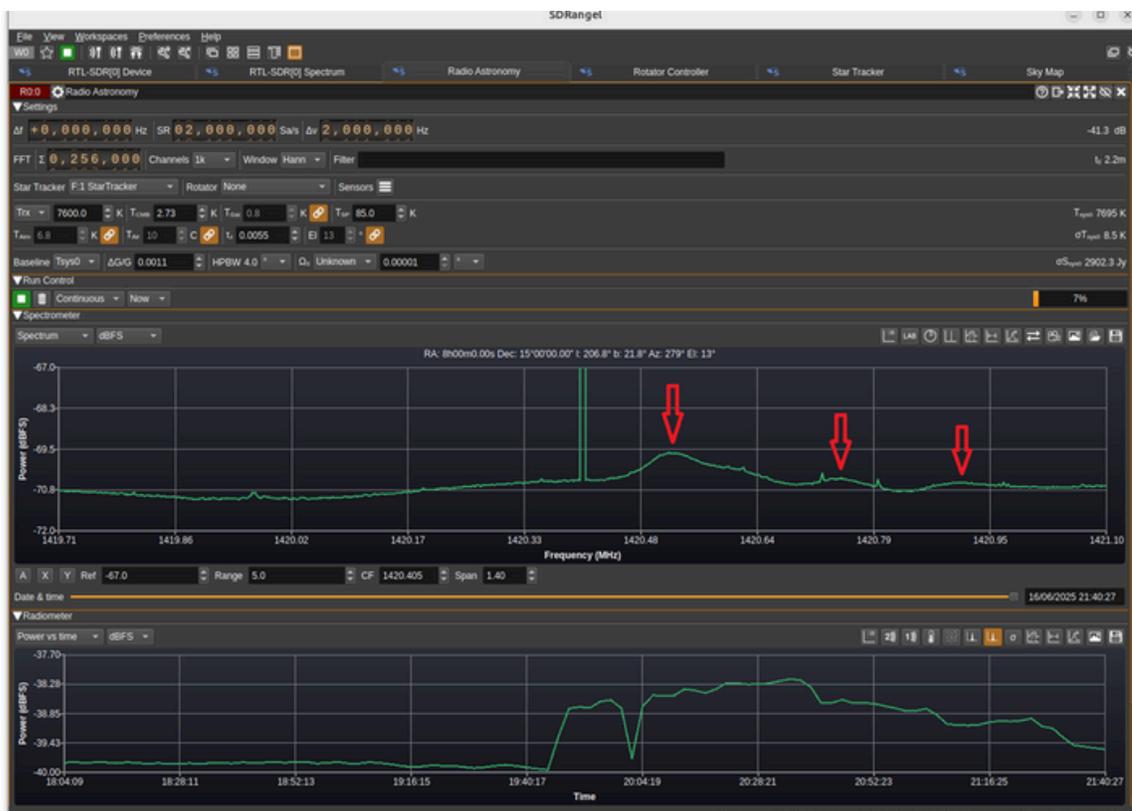
An example of a pretty strong source is NGC 7000, the North America Nebula. This is found in the constellation Cygnus the Swan near the star Deneb at: RA 20h 59m 17s, Dec +44° 31' 44" and is a pretty large source. The figure below shows the Radio Astronomy display for SDRangel and NGC 7000 is shown in the spectrometer graph. Red arrows have been added to show that this actually consists of multiple sources at different distances.

Like many SDRs, the one I am using has an artifact of a central spike at center frequency of the observation. This is very evident between the two frequency markers for 1420.33 MHz and 1420.48 MHz in the figure below. This isn't ideal but it doesn't really pose much of a problem. There

There is actually some benefit to having this spike. Since we know that the neutral hydrogen spin flip occurs at 1420.405 MHz, we should receive the signal at that frequency if it is a stationary source in radial velocity. Sources that are

observed to the right of that frequency are blue shifted – and are approaching us. Sources to the left of the central spike are redshifted and are receding from us.

To get more precise radial velocity values we would normally look at this information numerically in a file. But we can just use the display to get “ballpark” figures. These sources are pretty broad and I'll just use the three peaks, and this will allow



5.

us to determine the basic velocity of these sources. These sources are all blue shifted (i.e. approaching us). The formula for calculating the change in velocity (Δv) using the Doppler effect is:

$$\Delta v = c * (\Delta f / f_0)$$

Where:

Δv is the change in velocity (delta velocity)

c is the speed of light (299,792,458 meters/second)

Δf is the change in frequency (delta frequency)

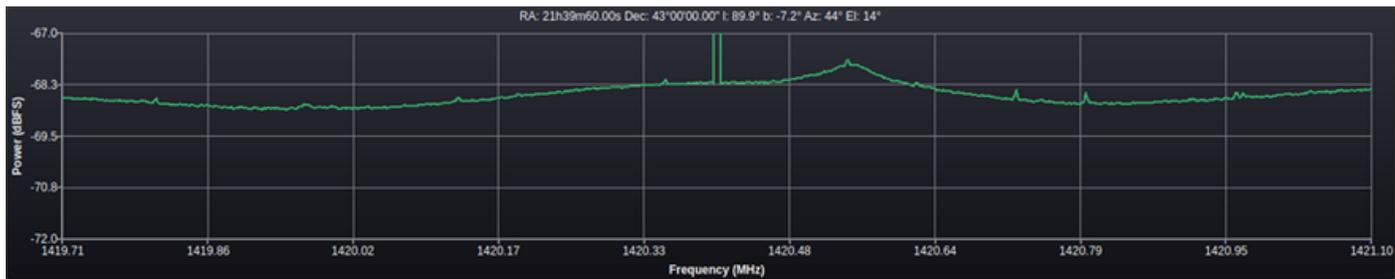
f_0 is the original frequency for the hydrogen spin flip (1420.405 MHz)

For the largest source, the first one on the left we get:

$$\Delta v = 299792458 * (.12 / 1420.405) = 25,327 \text{ meters/sec (25 km/sec)}$$

For the middle source we get: 71,760 meters/sec (71 km/sec) and for the rightmost source we get: 107,905 meters/sec (108 km/sec). And we were able to determine all of this with a small radio telescope.

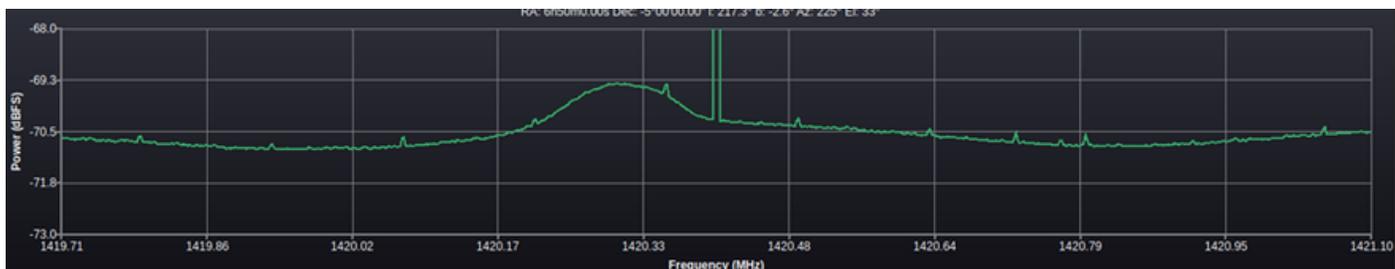
NGC 7000 is within the plane of the Milky Way, so to determine if we are really detecting an actual source other than the hydrogen continuum of the Milky Way, it's appropriate to move off of the source several degrees and then make another observation. The figure below is from RA 21h 40m and Dec 43° which is still in the plane of the Milky Way but a way from the North America Nebula.



Milky Way at RA 21h40m, Dec 43° - The Milky Way continuum peaks at 1420.54 MHz

This is also a broad line with a single hydrogen peak at 1420.54 MHz which would have a velocity approaching us at 28,493 meters/sec (28 km/sec). So, it seems reasonable that we have detected separate sources when observing NGC 7000.

As an example of a red shifted source, I also observed the Jelly Fish Nebula (IC 443) which is a supernova remnant (SNR) in Gemini as seen in the figure below.



IC 443 the Jelly Fish Nebula in Gemini - A single broad source peaking at 1420.29 MHz



Observing NGC 2244 during the day

As stated in the figure caption, IC 443 appears as a single broad source with a peak at 1420.29 MHz. From this I calculated that it is receding from us with a velocity of 23,744 meters/sec (24 km/sec). IC 443 is also in the plane of the galaxy so I completed another observation similar to what I did for NGC 7000 away from the source to determine that I really could see something other than the hydrogen continuum of the Milky Way. I haven't included a figure for this. One thing that may be evident is that pointing the radio telescope at different locations within the plane of the Milky Way would let us observe a lot of the structure of the Milky Way itself. This is because radio waves unlike visible light are such long wavelengths that they aren't blocked by the dust in the galaxy. Because of this, it is possible to use a radio telescope like mine to map out some of the spiral arms of our galaxy! How cool is that!

I still have a lot of work to do so that I can get good calibration values for my radio telescope. This will allow the observations to be made in units that are

more common in radio astronomy such as Jansky's (spectral flux density). I should also point out that in all of my observations I have neglected to subtract out the motion of the Earth around the Sun. This is something that can easily be done by making observations of objects spaced out by six months. This also leads me to point out one of the advantages of radio astronomy. Radio waves, unlike visible light are not significantly affected by sunlight or the Earth's atmosphere. So, you can observe during the day! The figure above shows the dish making an observation of the Rosette Nebula, NGC 2244 during broad daylight.

As I have said so many times – astronomy is absolutely the best hobby! There are so many different kinds of things that we can do as amateur astronomers. We may not have the equipment or the resources of the professionals but we also aren't at the mercy of only doing things where we can secure a grant. If there is something related to astronomy that you are curious about then take your time, study information available about it on the internet, ask other club members that might be interested in it or perhaps look for related clubs or email lists (i.e. see groups.io) for others that are interested in it, plod along and just do it! You may be very pleasantly surprised at what you can learn and do with this wonderful hobby!!!

Clear skies!



Questions? Email:

cvastrosociety@gmail.com

Improvements to the ZWO SeeStar S-50 included Software by Blaine Dickey

During the past year that I've owned a ZWO SeeStar S-50 there have been several changes to the software that runs the scope.

For me a much anticipated change was a new function called Plan. This function allows you to plan an entire evening of imaging beforehand. Once the plan is made a simple Execute command will start the plan running and it will continue all night without any intervention at all. After the plan is done the scope's arm will turn downwards so that it can't accidentally point at the sun and ruin the image sensor. Before turning off the scope you can view, denoise, and download the images to your phone or tablet. The included images in the constellation Cygnus were taken using this Plan function.

Another important item added was is the Mosaic function that allows you to take wider images. It takes multiple overlapping images and stitches them together to make a much larger image (up to 4x larger). You can also use Frame in conjunction with the Plan function. This allows you to rotate the frame your telescope will image so that the a best fit can be achieved. Because it is imaging a much larger field of view it also takes longer to make the image. The Mosaic image of the North American Nebula NGC 7000, shown below took more than 4 hours to record.

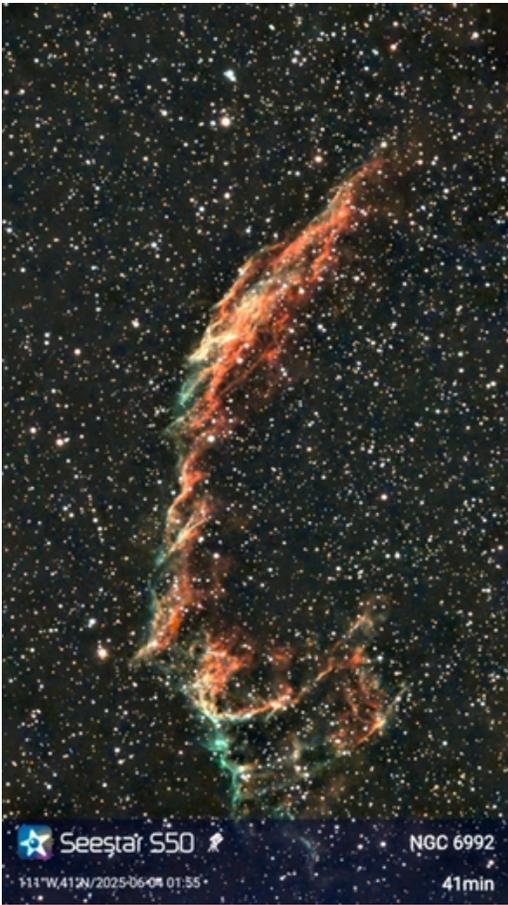
Another very useful function is the AI Denoise. During image acquisition a lot of noise can be seen in the resulting image. When you feel that your image is ready you can touch the AI Denoise function and it will magically remove all that unwanted noise. The resulting image looks much better and its all accomplished with the included SeeStar software. In connection to removing the noise, one can easily take a flat frame by holding a white sheet of paper in front of the objective. The flat will then be subtracted after each each image making it look better than it would other wise.

The most anticipated new function is called EQ mode that is used in conjunction with the use of an equatorial wedge. Before this function was available the telescope was essentially an Alt Azimuth telescope. It means that the telescope will move continuously in two directions, up and to the right. The problem with this is that the image slowly rotated and the edges of the image became quite noisy especially with long exposures. Another effect was that about 1/3 or more of the images were not stacked because of trailing in the images. The software tried to correct for this but only partially succeeded.

With EQ mode and an equatorial wedge the telescope now only has to move in one direction to track continuously thus eliminating rotation in the resulting image. The result is that the software rarely rejects any of the images and is able to shorten the time that it takes to make an image. All of the included images in this article were taken with an equatorial wedge in EQ mode. Longer single images up to 60 seconds can be made using EQ mode.

One improvement that I made with my set up was to add a bracket that holds an external battery power source. Since the SeeStar can realistically only function for about 4 or 5 hours it is not able to image all night long without an extra battery. I purchased a 10,000 mili-amp battery that has a short cable that plugs into the telescope keeping it easily going all night long, even on cold nights. The bracket and cable also prevent the cable from wrapping around the telescope.

Finally I have a plastic dew shield that fits into the objective end of the telescope reducing the possibility of dew forming on the objective, and reducing stray light from neighbors lights. If dew does start to form you can always turn on the included internal dew heater, though I never have had to use it even on very cold nights. I've found this telescope a joy to use and the resulting images are really pretty decent with not all that much effort.



Bryce Canyon and AstroCON 2025

By Bruce Horrocks

I just parked my truck and unhooked my camper on a hot Sunday afternoon, so I thought I'll wait until it cools down to unload all my dirty cloths and telescope gear. I just spent the last few days at Bryce Canyon Park attending the AstroCON event held at Ruby's Inn and the Astrovest event in the park. This was my first time to attend the AtrOCON, and I saw Dale Hooper there wearing some shirt from a previous event. While may ideas are still fresh in my head, I thought I would share a few things I learned and observed at the different sessions that I attended at the conference.

First- I met the famous Shane Larsen who is a professor who started the CVAS club years ago while a professor at USU. He was very friendly and fun to visit with. He asked me to tell you all hello and especially asked me to send his greeting to Tom Westre, Dell Vance, and Blaine Dickey. I thought it really is too bad that this guy is still not at USU. He had a lot of energy and even hauled a very large dobsonian telescope to use at the public Bryce Park viewing event.

Second – There is very little difference between a beginner astrophotographer and an advanced one. There were two sessions on astrophotography, one for beginners and one for advanced, and I must admit that many of the same slides were used in both presentations. Having sat through both lectures, I am going to say that pretty much all of you are in the advanced stages of astrophotography. The guy giving the presentation did a great job and later that day taught a third class on using Pixinsight. I wish there would have been another class on this as he went through the material pretty quickly, and it was hard to keep up. It left me realizing that I still have lots to learn on that software and the potential that it has. If you are not using this, it does come highly recommended. He did mention that the other programs like Siril are good too and if you like those keep with it and it will work great also.

Third – One lecture was on enhanced viewing using military night vision equipment added to your telescope. The guy went on and on how just how incredible this is to use, and you will just blow everyone away at the star parties if you have one of these in your telescope. Only just a couple of drawbacks to this are things like the cost, \$5,000 for a minimum set up to get going. Also, you cannot fly with this or take it out of the USA. I believe the fine for doing so was \$14,000 or so. Also, when you use this at a star party, since the device was developed by the US military, only American citizen can look through your telescope. I was thinking just how awkward this would be at a star party to have to see everyone's passport and check it off before they can look though your telescope. Again, the fine for not complying with this requirement I believe was \$14,000. I think I will just have to pass on this device even if it is really cool. If you are interested in it here is what it looks like.



Forth – Public Star Party at Bryce Park. Last year I went down to this as well. I thought it was really fun and met a lot of nice people, so I decided to make it part of my trip this year. It was great this year to see Dale Hooper there with some of his family and also Shane Larsen. There was a fire just outside the park as many of you may know, so I think this kind of reduced both the number of telescopes and the number of park visitors.

First observation about the star parties. Each night you were to attend a safety meeting. No issue with this as there is some risk with people walking around in the parking lot after it gets dark. The park rangers are very supportive and even provided us with dinner one night. It may have been over redundant, but they did have a guy trip and fall last year which resulted in his death. It kind of made me aware that we should show extra precaution when holding star parties and we have cables and gear strung all over the place. I found the red glow sticks to be a good source of red light that was not too distracting and could help keep folks from tripping over my tripod. They even worked better than the glow in the dark tape that some were using.

Second observation is just how many people come from all over the world to Bryce Park and Utah. Here is a great opportunity to meet people from so many different nationalities. I talked with a lot of people from France, India, Japan, a very nice couple from Germany who had just spent the previous night staying at the Hyrum State Park here in Cache Valley, and a two ladies who were traveling together one from Russia and the other lady from Ukraine. They said it is a very terrible thing going on between their countries and we have seen on the news. So, this star party is really an international event and a fun way to talk with people from all over the USA and the world.

My third observation about this was the volunteers. I look at this like any star party, it is our opportunity to provide some people with a look at the stars and maybe this will be their first experience looking through a telescope. In the safety meetings many of the volunteer astronomers started to complain about some overusing the red warning lights, several complained about the use of the green laser pointers, and others complained about people using their phones and getting a little bit of white light at the event. As I listened to their complaints I thought to myself, you guys should all go somewhere else to have your private star party and let these new people have a learning experience. How are you supposed to point out a star or a constellation without using your laser pointer? I think some of them thought this star party was for them and not for the park guests.

Conclusion – The AstroCON lectures were worth the trip and meeting with some other astronomers from across the country is always fun. I talked with several leaders from different clubs in the US from California to Kansas. Interestingly the percentage of active club members in most clubs is just about like ours is. I was jealous to hear how much money the San Diego club is given each year from some local jurisdiction (it was a lot !!). The smoke was not a big problem, but may have kept a lot of people home. I don't blame them, it is much nicer to have crisp clear skies and clean air to breathe. If you have a chance to go help here some time I hope you will and be a great representative of astronomy and our county.





Cache Valley Astronomical Society Presents:

A Public Star Party!

In Support of the Every Kid Outdoors Adventure Challenge

(<https://recreation.utah.gov/eko/>)

This event is free and is open to the entire family. In addition to telescopes where you look through an eyepiece we will also have smart telescopes which display the image on a screen. So even if you have a physical disability which prevents you from looking through an eyepiece - you will still get to observe the wonders of our beautiful universe!

This event will allow you to complete the Starry Skies Challenge.

The star party will be held in the south end of the Newton Reservoir parking lot at 41°53'54" N (41.89833), 111°58'24" W (-111.97334). Please see the map below, which includes where to park. Observing will begin around 9:30pm. [Since this is a star party, please avoid pointing white light flashlights at telescopes or other observers. If possible, please turn off any white light flashlights. Also, this event may be cancelled in the case of inclement weather. Please watch for details at <https://cvas-utahskies.org/>].



Friday, July 18, 2025, at 9:30 p.m.

Newton Reservoir (Park at the north end of the parking lot; party at the south end of the parking lot.)

Free and open to the public

Sponsored by the Cache Valley Astronomical Society

