GuideStar February 2023

A newsletter of the Houston Astronomical Society

Image by member:

Don Selle

Nightscape:

Madison River and National Park

Mountain - Yellowstone National Park

Fostering the science and art of astronomy through programs that serve our membership and the community

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Membership Renewals and New Member Adds on Hold

Hello all,

We're almost done with our website migration, so to make sure we transition everything over properly, we're putting all membership renewals and new member processing on hold until ~~January 9~~. *Editors note*: A number of members are testing the renewal process and the new member joining process. Please bear with us as we get through the migration. We will announce when you may renew your membership when the migration is over. Thank you very much for your cooperation.

Regards,
Joe Khalaf
HAS President

February Novice Presentation

February 02, 2023, 7:00PM: February 2023 Novice Meeting via Zoom

"Putting your Observing in Context"

by Chris Morisette

“

As novices our early efforts are spent trying to find then admire objects of interest in the night sky. Inevitably we start asking… what exactly am I looking at, how did it get there, and where is it with respect to us and everything else? In “Putting Your Observing into Context” we’ll perform a brief survey of the Universe exploring the processes and structures that define the cosmos.”

Our Speaker: Chris Morisette is HAS Novice Chairperson and is also an active member of the North Houston Astronomy Club and the Fort Bend Astronomy Clubs. He is also a member of the University of Texas Astronomy Department Board of Visitors and is a regular volunteer at the George Observatory.

February Regular Meeting

February 03, 2023, 5:00PM: February Regular Meeting - Online via Zoom

“Cosmology: How we know what we know about how the Universe works”

With: DR. Niv Drory

McDonald Observatory / Dept. of Astronomy

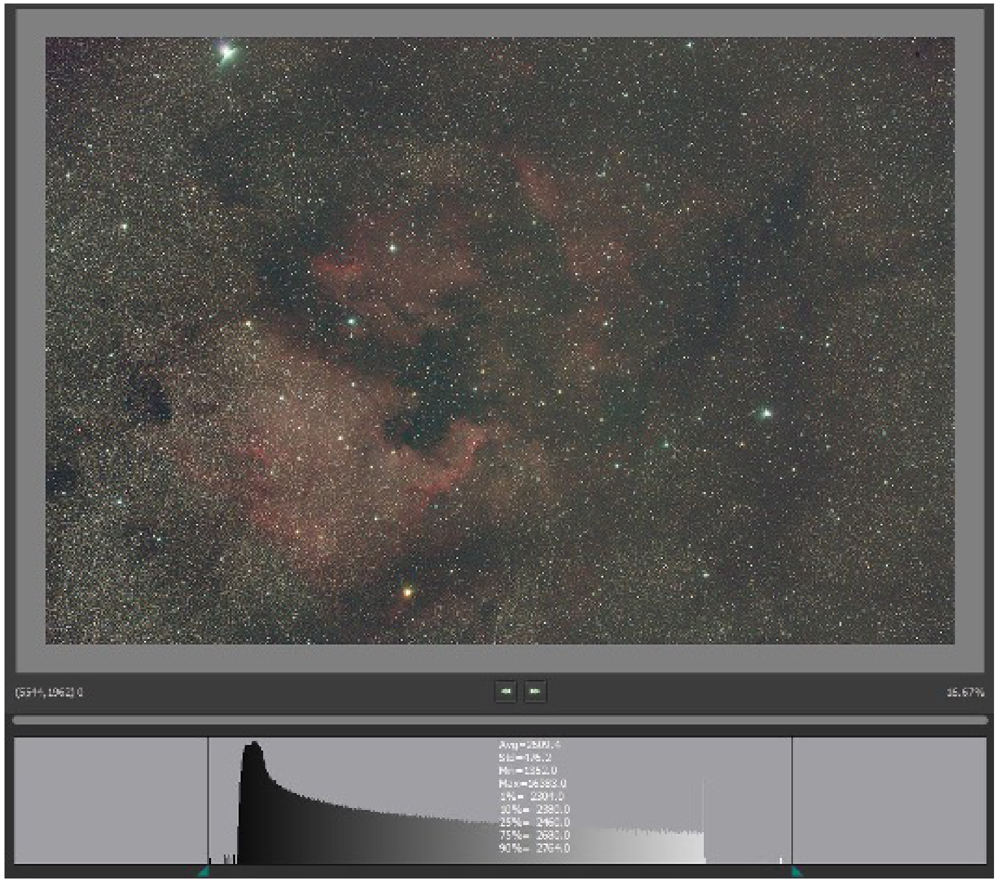
The University of Texas at Austin

Abstract – 50 years ago we had a theoretical framework, General Relativity, to explain what cosmologies are possible, but little data to tell us what the universe really is like. Today cosmology is a precision science with most of the fundamental quantities known to percent level precision. What has enabled this progress and what data are the bedrock upon which our detailed knowledge of the science of cosmology is built? What questions remain open, and what will future data be able to tell us?

Our Speaker – Dr. Niv Drory – Niv was born in Israel, obtained a PhD in Physics at the University of Munich, Germany, writing his thesis on the first wide-field near-infrared survey of distant galaxies. He came to Texas for the first time as a Humboldt Fellow in 2002, where he joined the early work on Hobby Eberly Telescope Dark Energy Experiment (HETDEX). Niv has been a research staff member of the Max-Planck Institute for Extraterrestrial Physics (MPE), and spent 2 years as a Professor of Astronomy at the National Autonomous University of Mexico (UNAM). He is interested in Galaxies, Cosmology, and Instrumentation. He returned to Texas in 2013 to work on the HET Wide-Field Upgrade and HETDEX, and is now a Senior Research Scientist at McDonald Observatory. He is also deeply involved in the Sloan Digital Sky Survey as Instrument Scientist for MaNGA in SDSS-IV and PI of the Local Volume Mapper in SDSS-V.

Getting You Exposed Part 2: Astrophotography

By Don Selle

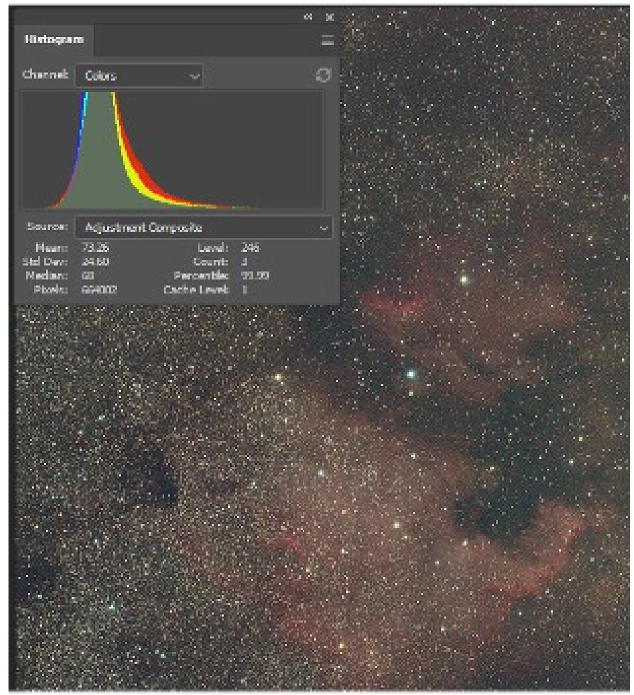


Part 1 of Getting You Exposed, dealt with the concept of Total Exposure time and Exposure Value. It also provided some rules of thumb to help you estimate the Total Exposure time required for various types of targets using your own imaging rig. Having a good idea of the Total Exposure is certainly essential for acquiring high quality data on the low light level targets we image, but it is only one factor we need to consider.

Since most targets will require several hours of Total Exposure time to acquire enough data to assemble a quality image, we will typically acquire that data using multiple sub-exposures (aka sub-frames). The exposure time for each sub-frame when summed will equal the Total Exposure time of the acquired data.

When you think about it, this makes sense. You wouldn't want to take hours long single exposures as too much can happen. Satellite photo-bombs, mount tracking errors, autoguiding errors, operator error and things that bump your tripod in the night can ruin your sub-frames and result in the waste of a lot of time. Even back in the days of film, to avoid these risks, astro-imagers took multiple exposures, developed them, then scanned and electronically combined them to reduce the noise in the image.

Once the decision is made to make up the Total Exposure time through some number of shorter duration sub-frames, the question arises – how long should each sub-exposure be? Since the risk to individual subframes increases as sub-frame exposure time, shorter may be better, but how to know.



Back in the day when I got started astro-imaging, there was no set answer. The best advice at the time was to set your sub-frame exposure long enough so that the "hump" in the sub-frame histogram started at 25%-33% of the left side of the graph.

I didn't know it at the time, but this rule of thumb was a statement of the photographic technique commonly referred to as "exposing to the right" or increasing the exposure of your photograph so that details in the shadows are sufficiently exposed but the highlights are not saturated or "blown out". This way, the darker details can be recovered during processing.

A little explanation is in order here. The photo on the left is a crop from a single sub-frame (it is raw i.e., no processing) with a histogram of the complete frame shown on top of it. The histogram shows the range of pixel brightness levels (0-255-actual values converted to 8-bit color) from left to right across the bottom of the graph with the total number of pixels in the frame which are at each of the brightness levels. While it is not totally apparent, each of the three RGB color channels is displayed on the histogram, as well as statistics for the whole image at the bottom. (There is a lot more information in the histogram, but that's the subject of a future article!).

This histogram pretty well illustrates the expose to the right rule of thumb. In truth, I estimated the exposure time based on a method which I will describe for you. It relies heavily on the mathematical theory behind signal processing and has been reduced to a couple of simplified calculations and software tools. When the appropriate values representing the performance of your imaging system and the quality of the night sky you are under, will provide a very good estimate of the optimum sub-frame exposure time.

When I updated my imaging system, replacing my older mono CCD camera with a new OSC CMOS camera, I initially continued to use the same routine sub-frame exposure times. I later learned (from my friend and advanced imager John Talbot [1]) about how improvements in camera technology which have been incorporated into the newer CMOS cameras can help improve the raw data you capture. I recently have begun to use a new method of estimating my sub-frame exposure times which is based on mathematical signal processing theory as applied to imaging.

I will not go too deeply into the theory. For those who are mathematically inclined and interested should spend an hour and watch Dr. Robin Glover [2], the developer of SharpCap describe the theory and how it is used. Dr. Glover has extended the work done by others and developed some very interesting tools which he has included in SharpCap which will do the calculations for you. In truth, once you have the right information about your camera, optics and the sky brightness where you image, thanks to calculator Glover has made available on the SharpCap website, you can make a very good estimate of optimum sub-exposure time with a simple hand calculation. A precise calculation requires that you take an image of the night sky so that the sky brightness can be measured.

It is worth noting that Glover is neither the first nor the only person to develop the theory and tools necessary to determine optimum sub-frame exposure time using signal theory, and Glover's approach is very similar to and compatible with what has been done previously which required a direct measurement of sky brightness.

In the current era of very low noise CMOS cameras, Glover has championed the idea of taking very many short exposure sub-frames which in some applications, might eliminate the need for autoguiding, and allow use of mounts with less precise tracking. Dr. Glover has also provided an online tool to assist in estimating the sky's brightness in order to estimate the optimum sub-frame exposure time.

Signal Processing Theory

Determination of the optimum sub-frame exposure time is based on the application of signal processing theory applied to astro-images. All of the sources of noise that end up in each sub-frame are identified and quantified. These noise sources can be organized into two categories, systematic noise and shot noise.

Systematic Noise - is noise such as dark current or thermal noise and bias pattern noise. This noise can be directly removed from the subframes during calibration with only a small random amount remaining. (See my AP Corner "Let's Get You Calibrated" https://www.astronomyhouston.org/newsletters/guidestar/ap-corner-let%E2%80%99s-get-you-calibrated#overlay-context=welcome

Shot Noise – Removing systematic noise leaves what is commonly termed Shot Noise, or the noise which is specific to each sub-exposure. Shot noise is comingled in the raw frame and is not removed during image calibration and consists of two major noise sources – Sky Noise and Read Noise. Shot noise is dealt with during image processing, after the calibrated sub-frames are stacked to improve the Signal to Noise Ratio.

Sky Noise This is primarily noise coming from the sky (a.k.a. Sky Background) which is not associated with either the stars or the target in your sub-frames. The biggest component of sky noise is light pollution, but even at the darkest sites there is still a sky background. It is made up of the dim diffuse natural light reaching the Earth from space, as well as the natural sky glow which is due to the light given off by ions created by sunlight striking the atmosphere, when they recombine. Sky noise is mostly removed by subtraction with a small random fraction remaining.

Read Noise Noise is added to each sub-frame by the camera and is commonly called Read Noise. It is generated during the process of collecting the photons, converting them to electrons and then reading them out and converting them from a voltage into a digital number. Read noise (along with any random sky noise) is dealt with by noise reduction algorithms during image processing.

Optimum Sub-frame Exposure - We do need to define what optimum means. The assumption is that as we described above, the risk of outside factors messing up a sub-frame increase with increasing exposure time. This means that finding the shortest exposure which can sufficiently capture the faint detail present in our targets and capturing enough of them in order to significantly improve the signal to noise ratio of these faint details is the optimum sub-exposure time.

Determining Optimum Sub-Frame Exposure Time

The most accurate way to determine your sub-frame exposure is to use a tool which actually makes measurements of your camera and of the sky glow at your imaging site. SharpCap[3] has a comprehensive tool to do this for supported cameras called Smart Histogram. When coupled with the Sensor Analysis Tool SharpCap will take images of the night sky, determine the key parameters for your system and measure the sky noise, then do a full calculation for you, of how long your sub-frames should be exposed, and how many to take. I've personally not used it but I have gotten good reports from several imagers who have. Frankly, the tools sound very impressive, especially if you use SharpCap and are willing to spend the time measuring the sky background.

If you are like me and already have invested considerable time into learning and setting up an imaging software system and would prefer not to switch horses. You can easily calculate a good estimate of optimum exposure time with the following equation:

The SharpCap method

$$C^* (R^2/P)$$

R = Camera Read Noise (RN) in electrons

P = Sky Noise rate measured by your camera in electrons per second

C = Preferred % Read noise is of total Shot Noise (where Shot Noise = Read Noise + Sky Noise)

% RN	C Factor
1%	= 50
2%	= 25
5%	= 10
10%	= 5
20%	= 2.3
25%	= 1.8

The calculation I made for the example sub-frame exposure was as follows:

R = 2.2 electrons at ISO 3200 for my Canon 6D and a 300mm f/4L lens - value based on review on www.ClarkVision.com

P = 1.92 electrons per sec for Bortle 4.0 location

C = 50

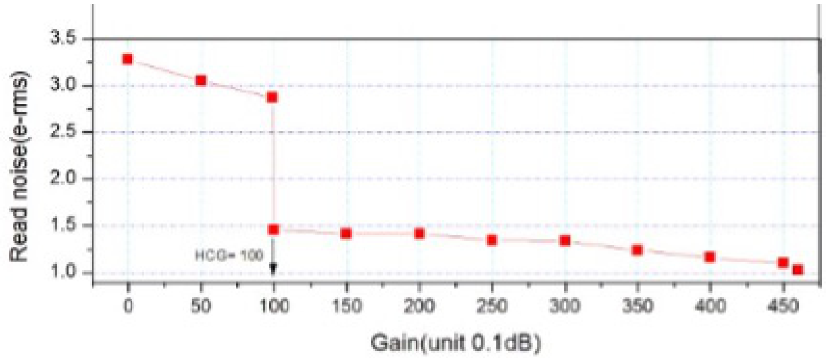
Recommended exposure = 126 seconds – and I used 120 secs, a round number and because I was using a camera tracker and had verified that I was able to get reasonable results with 2-minute exposures without guiding.

Determining the R and C Factor Electrons

From the above formula it is clear that we need to determine two key factors, the read noise in terms of electrons, and the sky background rate in terms of electrons generated in each pixel per second due to the sky flux. Fortunately, there are good resources to determine both values.

Camera Read Noise Electrons

If you own a recent model astro-imaging camera you are in luck, as most manufacturers are now specifying the read noise inherent in their cameras in terms of electrons. Some are even providing data fully characterizing the camera performance at various levels of gain, as shown below for a very popular ZWO monochrome camera. In addition, SharpCap also contains a tool that will allow you to test your own camera.



For DSLRs though, the situation is a little more complicated in that the manufactures such as Sony Canon and Nikon do not publish this information. Fortunately there are several good sources where talented individuals have made the effort to test and publish data on popular DSLRs. For older model DSLRs, especially by Canon, and some Nikons models you can find data on many models on the ClarkVision.com website at:

https://clarkvision.com/articles/digital.sensor.performance.summary/index.html

For a more comprehensive set of data for many DSLR manufacturers and models you can check out the website photonstophotos.net which has a comprehensive set of read noise data.

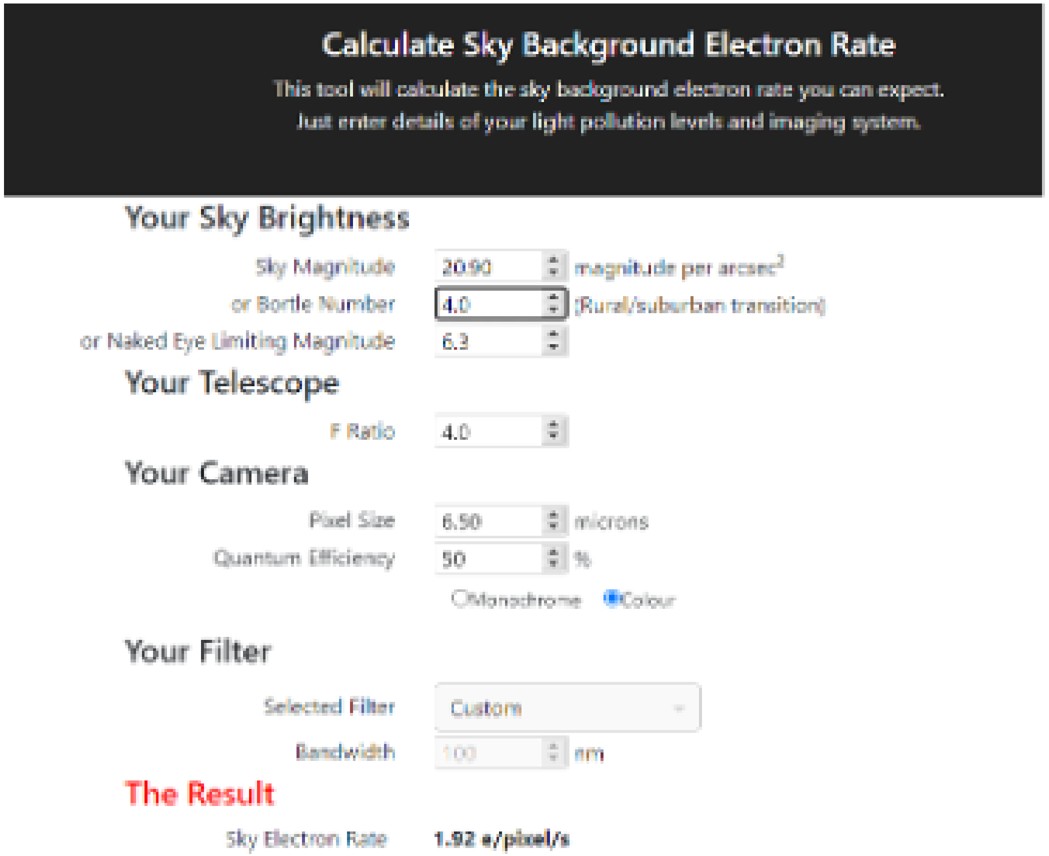
https://www.photonstophotos.net/Charts/RN_ADU.htm

If your camera is in both sources, my preference would be to follow ClarkVision since its author Roger Clark is focused almost entirely on nightscapes and astrophotography.

Sky Noise Electrons

The calculation to determine sky background is based on the site you are imaging from, the optics you are using, including any filters and characteristics of your camera. Fortunately for us, Dr. Robin Glover has provided a very straightforward website tool that makes this calculation very easy.

http://www.tools.sharpcap.co.uk/



My friend John Talbot has even suggested setting up a spreadsheet to help you plan for imaging with various imaging rigs and at various sites. Keep in mind that the results of this calculation are just very good estimates, so use them accordingly as suggestions. If you want to make the estimation even more accurate without imagining, you might even use a Sky Quality Meter (SQM) to measure your sky brightness!

Clear skies and happy imaging!

Notes

1. Equations and spreadsheet example come from a talk my friend John Talbot gave at both the 2022 Advanced Imaging Conference and at the 2022 Okie-Tex Star Party. You can see a video of John's AIC talk here: https://www.advancedimagingconference.com/articles/new-generation-cmos-technology-jon-talbot
You will need to join the AIC website; it is free and the full library of videos from past conferences is available for viewing. Join AIC here: https://www.advancedimagingconference.com/subscribe

2. Dr. Glover's video https://www.youtube.com/watch?v=3RH93UvP358
3. https://www.sharpcap.co.uk/sharpcap/features/smart-histogram

In Good Company: Leland Dolan

In good company, you are, as you spend your time here with members. Here is one: Leland Dolan. Leland stayed with us a long time but he had to go away to where we all will go one day. Leland thought highly of us, has left a gift for us.

Let us be worthy. Let us continue this endeavor.

Thank you, Leland.

A Midsummer Astronomer's Daydream, featured in this edition, was written by Leland.

Read more about Leland Dolan

A Midsummer Astronomer's Daydream

By Leland A. Dolan

(From the September, 1987 issue of the GuideStar)

Perhaps one reason I was picked as historian, is that I tend to dwell a lot on the past. I still think of my early years as an amateur astronomer as the "good old days". The chief difference between, say 1960 and now, is that I could observe a number of Messier objects from my yard, and yet I lived only a quarter mile from the University of St. Thomas. For observing or photographing the Milky Way, I would spend the night at my parents' home, only a couple of miles west of Memorial Park. Nowadays, to go anywhere where one can observe deep sky objects, requires that two or three hours be spent travelling to and from the observing site.

But, Let's take a look into the next century. No this article is not going to be a “downer” but an imaginary view of what might be possible in the future. WARNING: This article is perhaps outrageously speculative, and will not appeal to the hard-bitten realist. But, for those who like to dream, dream along with me.

It is the summer of 2005 and, in spite of the serious light pollution, there is widespread interest in astronomy and (especially) space. Professional astronomers are now using several medium-sized telescopes on the moon, while awaiting completion of two large multi-mirror telescopes to be located near the east and west lunar limbs respectively. No, astronomers do not travel to the moon to observe but operate these instruments from their labs by remote control. This is an outgrowth of the way spacecraft were operated to photograph during the late Twentieth Century.

With these techniques being perfected, amateur astronomical societies are now building telescopes in remote locations, and operating them from their society's “clubhouses”, usually in a central location. The golden anniversary of the Metropolitan Houston Astronomical Society, (formerly known as the Houston Amateur Astronomy Club and later, the Houston Astronomical Society), is approaching and everybody is excited especially since the society has just acquired, thanks to the generosity of a wealthy benefactor, a forty-inch reflector, which is being installed on the slopes of Mauna Kea. This is the last totally unpolluted observing site in the United States. And it was only through an agreement worked out with developers that, by allowing them to have all of Oahu, the “big island” was preserved from commercial development.

Access to the new telescope will be by reserving time, as is customary with most observatories. There will be little “real time” observing, however, since midnight in Hawaii occurs at 4AM Houston time. So, astronomers program the computer inserting one's personal identification code and, at the allotted time, the instrument records the image, just as TV viewers recorded programs on VCRs twenty years earlier. Then, at the astronomer's leisure, the image is processed to bring out details, something only professionals did during the Twentieth Century.

Activities include comet hunting, which seems less romantic now, since an area of the sky is simply “photographed” with an imagedevice (that makes the first CCD look like a toy) and the computer compares previous exposures of that area and reports any anomalies. With this technique amateurs have discovered numerous asteroids and even faint novae.

But, there are still those amateurs who like to gaze up into the firmament, just for pure inspiration. For them, there is the Texas Star Party, now in its third decade. No longer do they bring sophisticated telescopes but rather Dobsonians, RFTs and just plain old-fashioned binoculars. In today's complex world, there is nothing that refreshes the soul like viewing the constellations at low power, or even with the naked eye. This is something that our technological world has nearly robbed us of.

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This article was typed by me as written with no changes to the original text. Any typos introduced during the typing process are my doing. Many long-time members of the HAS will remember Leland, newer members may not. He continued to attend HAS meetings at the University of Houston and participate in the activities of the organization until his passing.

This issue of the GuideStar (9/1987) also includes an Observatory Corner article and other items of interest to current HAS members. So, more to come.

Clear Skies to all;

Bill Pellerin, former GuideStar editor, former HAS President.

Ramp Up Your Game

Many, maybe most of you, have at least dabbled in the famous Messier Catalogue as a good deep-sky starting point for your observing efforts. The problem with Charlie Messier is that his catalogue has as a primary purpose, the identification and location of objects that looked suspiciously like comets through his 3.5-inch telescope. After all, he was a world-renowned comet chaser. He did not want to waste his time looking at/for things that looked like, but were not, comets.

Comes the NGC/IC catalogues. The *New General Catalogue of Nebulae and Clusters of Stars (NGC)* is an astronomical catalogue of deep-sky objects compiled by John Louis Emil Dreyer in 1888. The NGC contains 7,840 objects, including galaxies, star clusters, and nebulae. Dreyer published two supplements to the NGC in 1895 and 1908, known as the *Index Catalogues (IC)* describing a further 5,386 astronomical objects. Thousands of these objects are best known by their NGC or IC numbers, which remain in widespread use.

13,226 is a bunch of objects, many of which are low on the exciting scale or are just plain not visible in backyard telescopes. However, some are quite spectacular and we can all enjoy them with reasonable glass and viewing conditions. The following list contains a small group of the best NGC/IC objects easily visible in late winter.

Source: RASC Finest N.G.C. Objects v2 Observing List, evening of 2023 Feb 18

Sunset 18:17, Twilight ends 19:36, Twilight begins 05:41, Sunrise 07:00, Moon rise 06:50, Moon set 16:34

Completely dark from 19:36 to 05:41. New Moon. All times local (CST).

Listing All Classes.

The minimum visual difficulty of each object is either: visible, obvious, easy, or apparent, but not ~~difficult, challenging~~, ~~very difficult, or not visible.~~ These ratings according to Sky Tools 4 Pro based on a nominal 8-inch SCT telescope under fair to good observing conditions.

Primary ID	Alternate ID	RA (Ap)	Dec (Ap)	Mag	Rise	Transit	Set
Blue Racquetball	NGC 6572	18h13m12.5s	+06°51'22"	8.0	02:23	08:41	15:03
Cat's Eye Nebula	NGC 6543	17h58m31.3s	+66°37'31"	8.3	-	08:26	-
Blue Snowball	NGC 7662	23h26m58.4s	+42°39'41"	8.6	05:43	13:58	22:09
Clown Face	Eskimo Nebula	07h30m33.4s	+20°51'51"	8.6	15:07	22:00	04:53
Blinking Planetary	NGC 6826	19h45m23.3s	+50°34'35"	8.8	01:11	10:13	19:19
Cleopatra's Eye	NGC 1535	04h15m20.4s	-12°41'02"	9.4	13:12	18:45	00:19
Turtle Nebula	NGC 6210	16h45m27.0s	+23°45'10"	9.7	00:12	07:13	14:18
Ghost of Jupiter	Eye	10h25m53.7s	-18°45'37"	8.6	19:37	00:55	06:13
NGC 281	IC 1590	00h54m08.0s	+56°45'19"	6.7	05:07	15:25	01:39
h Persei	Double Cluster	02h20m36.3s	+57°14'15"	4.6	06:24	16:51	03:14
NGC 7027	n/a	21h07m51.2s	+42°19'33"	9.6	03:26	11:35	19:49
Chi Persei	NGC 884	02h23m54.9s	+57°14'41"	4.7	06:27	16:54	03:18
ET Cluster	Dragonfly	01h21m00.4s	+58°24'36"	4.7	04:57	15:51	02:42
NGC 2244	NGC 2239	06h33m09.1s	+04°55'27"	4.7	14:49	21:03	03:17

PRACTICE PATIENCE!! Spending time with each of these deep-sky wonders will pay dividends in the amount of detail you'll see. Don't worry about rushing out right away on a subpar night. Many of the objects on this list will linger high in the sky throughout most of the late winter and early spring.

RESEARCH!! I encourage you to perform a little research before embarking on your journey to help you understand the science behind the object and to appreciate its beauty. I have found Wikipedia to be a good source. But there are plenty of resources with more details. Track them down.

REMEMBER!! The only rules for any observation session are to embrace the challenge and to have fun!

Jim King

Getting Started in Observing

When I first started out observing sometime in late 1960's, some friends and an astronomy lab instructor pointed out some objects using my school's 12" that was mounted on top of the science building. But the thing that they did not show me were the fundamentals of observing. It was sort of like telling you to get in a car and drive to Dallas without telling you what stop signs, and the brake pedal and police cars are. You must learn these before you can start going places. Observing is not that much different. Here are a few things that, when time is invested at the beginning, will pay back many dividends when at the eyepiece.

1 One of the first things to learn are the constellations. Not all of them (you can't see all of them from Houston) but the brighter ones. Constellations like Orion, Ursa Major and Minor, Scorpius, Virgo Hercules (that's a tough one) and the brighter ones in the Zodiac. The constellations that have bright stars. Don't waste your time yet when all the stars in a group can't be seen from the city.

2 Learn how to read star maps. Don't get the kind that have so many stars in a small area of the sky on the biggest sheet of paper. Get the more condensed maps such as the Mag 5 or Mag 6, or the Pocket Sky Atlas. As time goes on you will eventually get the Sky Atlas 2000 or Uranometria and then on to the Palomar Observatory Sky Survey.

3 When learning to read star maps, you begin to understand directions in the sky. When someone says to look north, this does not mean "UP" but toward Polaris. South means toward the south, not down. Likewise, east means towards the horizon where stars rise, and west is where the stars set. It will impress visitors when you these terms rather than up or down and left and right.

4 If you have a telescope, learn all about it. Learn what directions it moved, how to align the finder with the main optics, how to collimate it (if yours is of the type that is constantly required, typically Newtonians), how to polar align (if yours has drive motors). When looking through the eyepiece, learn the directions north, south, east and west. Learn how big (field of view) of an area of the sky that you are looking at with each eyepiece (typically about 1 degree or less) and how this relates to the star map that you are using. You can find the field of view by letting a star near 0 degrees declination drift through the eyepiece from one side to the other and seeing how long in minutes it takes. Take the time and divide by 4. This is how many degrees the eyepiece covers.

5 Next, learn to recognize the brightness of stars, their magnitude. You don't have to recognize them down to 0.1 magnitudes, or even 1 magnitude, but within, say, 2 or 3 magnitudes. First do this with naked eye stars. Then, even more importantly, is to recognize the brightness when looking through your scope. When the description of an object says it is near a 9th magnitude star, is that star in the eyepiece 9th? Or 13th? Another key item here is "how dim a star can your scope pick up"? under the current sky conditions. There are no magic formulas for this, just practice and time.

6 Plan an observing program. It doesn't not have to cover all night, maybe just 5 objects, or 10 objects, or learn 2 new constellations. Leave yourself time to just "scan the skies" with your scope, naked eye or binoculars. And leave time to "eavesdrop" on conversations of others and peeks through their scope. Maybe set a multiple-night goal, like getting your Messier or Herschel Certificates. You will feel

a lot better knowing you set out a goal and met it.

7 Be persistent when looking for an object. After 30 seconds trying to see the object, don't say it doesn't exist anymore or the star charts are wrong.

8 Keep an observing log. It can either be a "general" log with the date, where, with what scope and eyepiece with the name of the object. Or it can be detailed that tells the date, location, time and seeing conditions of each object and what the object looked like. To help with the description, think about how you would describe the object to a blind person. If going for an Astronomical League observing program, this information is needed. This log will be fun to look back at in 5, 10 or even 30 from now.

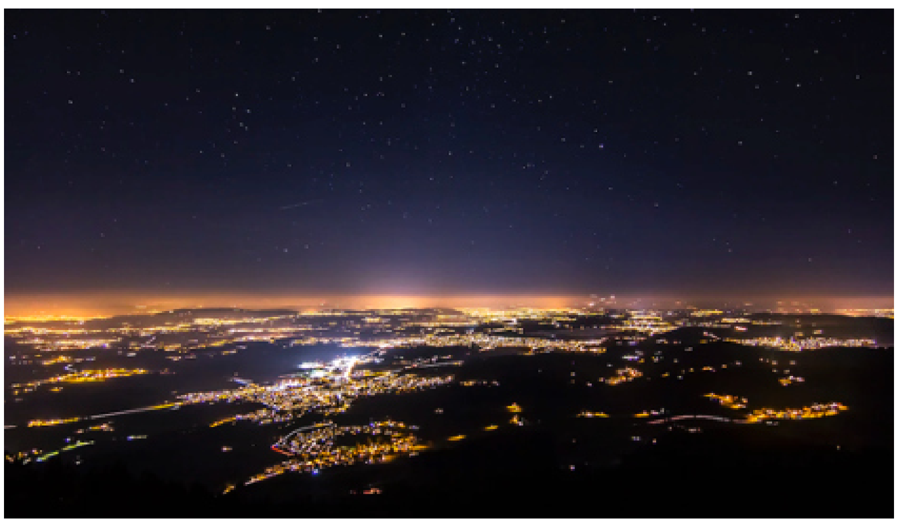
9 One of the most important things to remember when observing is that it is ok to ask for help. 99% of the people observing will gladly stop to help another observer, whether experienced or novice. Our membership would be a lot smaller if the advanced observers didn't stop to help the novice. It is even more fun when observing with other people around, as at our Dark Site.

Doing your preparations for observing and learning the basics first will greatly enhance your pleasure during observing and you will look forward to your next session.

Steve Goldberg

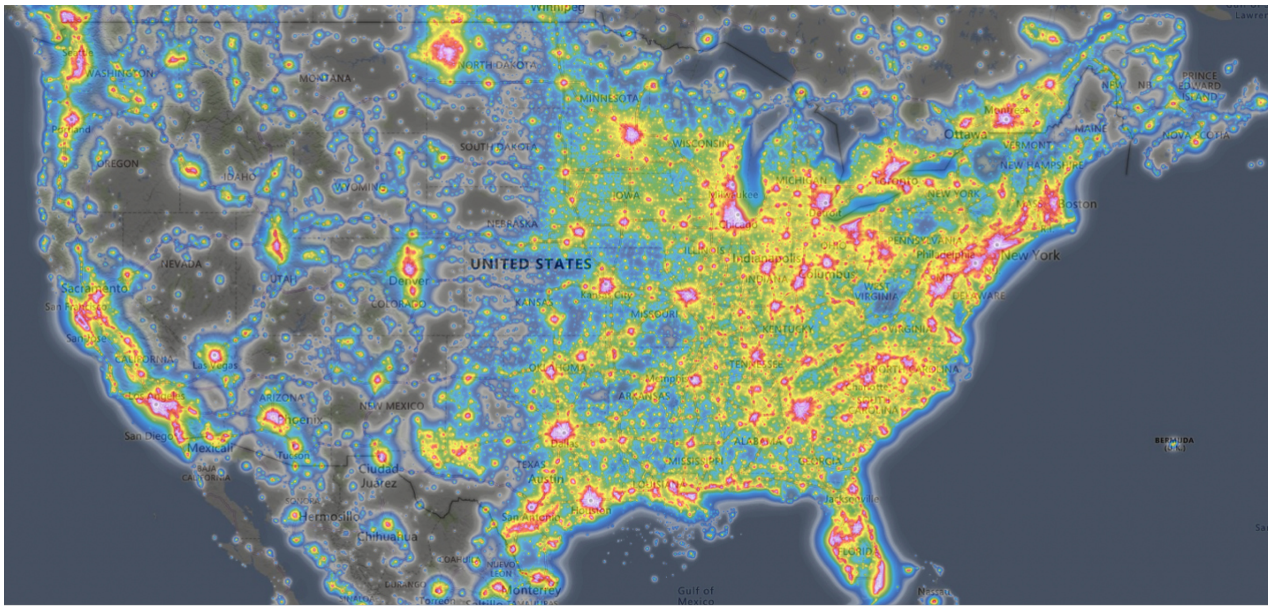
Light Pollution: New Report Shows It's Worse Than We Thought

By Will Sager



Light pollution from a mountaintop in Switzerland. Photo by Jan Huber.

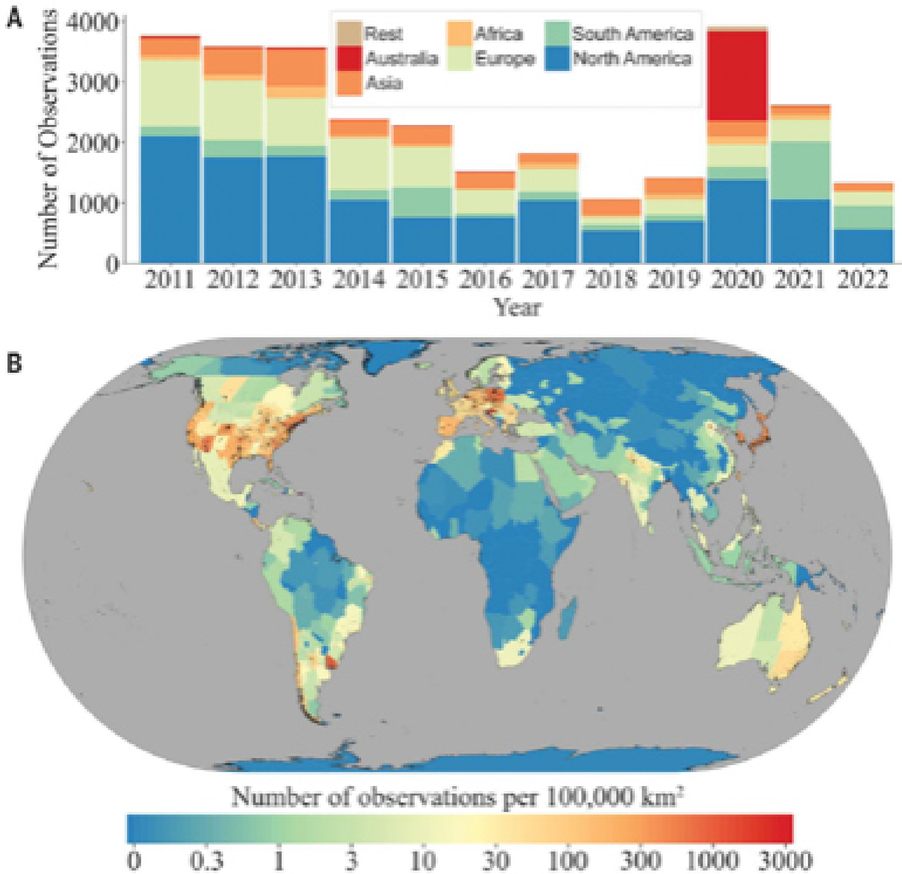
Every astronomy enthusiast knows about light pollution, especially those of us under the Houston light dome. We watch our skies and get the feeling that the sky gets brighter as development grows apace. Using data collected by citizen scientists, a team of researchers from Germany and the US reports in the journal Science (Kyba et al., 2023) that light pollution is growing faster than previously thought. The researchers used more than 50,000 observations submitted by citizen scientists from around the world, in which observers estimated the faintest stars visible from their site (Naked Eye Limiting Magnitude or NELM). The connection, as we all know, is that as light pollution increases, light scattering increases and this limits the visibility of dimmer stars. The scientists found an unsurprising correlation between citizen observations and locations of increased light pollution measured by satellite. What was surprising was that to match observations of decreasing NELM, the researchers had to model an increase in light pollution (sky brightening factor) by 9.6% per year. With this rate of increase sky brightness doubles in eight years. This rate is significantly greater than satellite observations, which grew by 2.2% per year globally between 2012-2016 and about 1.6% from 1992-2017.



Light pollution in the continental United States. (from https://lightpollutionmap.info)

Why the mismatch? The authors note that the sensitivity of satellite sensors is with wavelengths shorter than 500 nm. As older gas-discharge streetlamps emitting longer wavelengths have been replaced by LED bulbs that emit shorter wavelengths. Thus, some of the light is not being detected by the satellites. Moreover, the satellites detect mainly direct light, but not light reflected off the ground or other objects, which contributes significantly to light pollution. The authors conclude that the visibility of the stars is decreasing rapidly and existing lighting policies are unable to prevent increases in skyglow. Moreover, the authors think that switching to LED lights is a double-edge problem. Not only are shorter wavelengths being emitted, but the fact that LED lights are cheaper is encouraging people to install more lights.

The study highlights a venue in which average astronomy enthusiasts can contribute. Data for the study were collected by the Globe at Night program (https://www.globeatnight.org), which is run by the National Optical-Infrared Astronomy Research Laboratory (NOIRLab). It collects data from anyone who wishes to contribute. No special equipment is needed (star maps are provided for the purpose) and are easy to make, but SQM (sky quality meter) data are also encouraged. Although the data set is heavily biased by observations in the US and Europe, a glance at maps of observation locations shows that data distribution is low, even in those highly sampled areas. It was surprising to find that yearly observations are declining (see figure) and there are only a few observations from Houston (and none from the Dark Site). This is clearly an area where astronomy clubs and their members can make a significant contribution to science.



Distribution of Gl

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https://www.globeatnight.org

https://www.lightpollutionmap.info

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