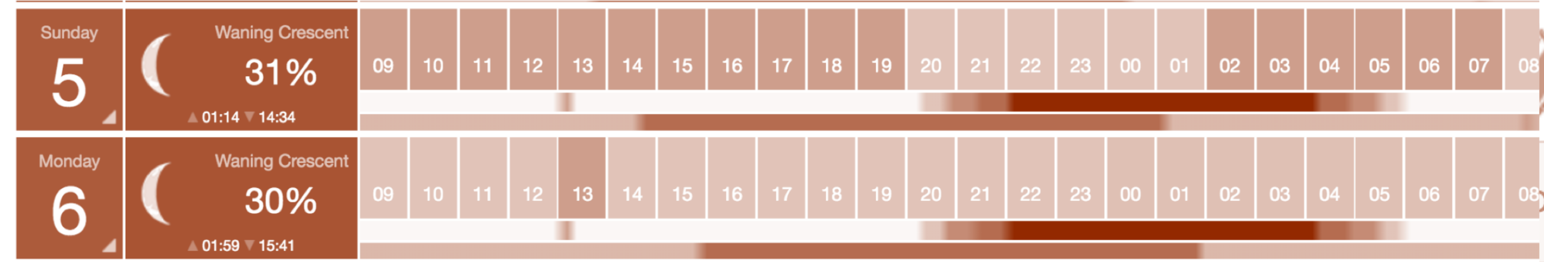
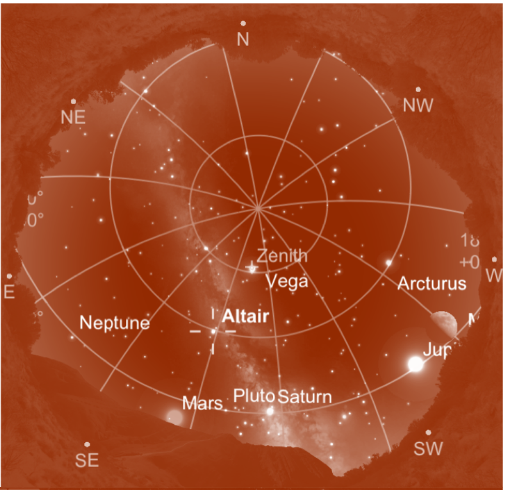
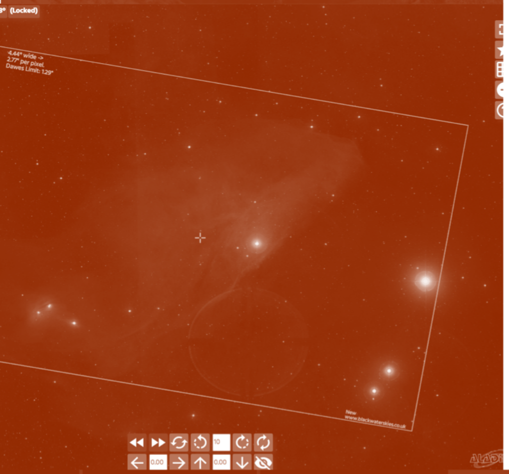




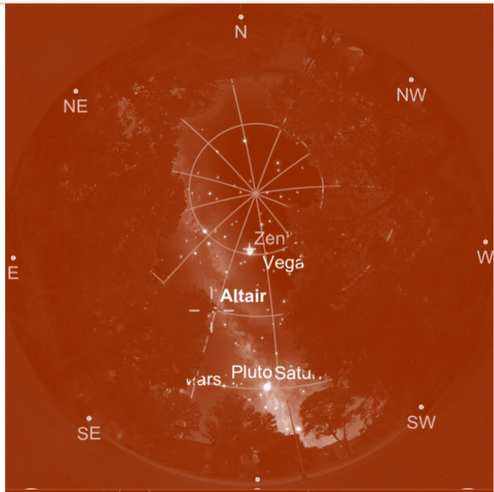


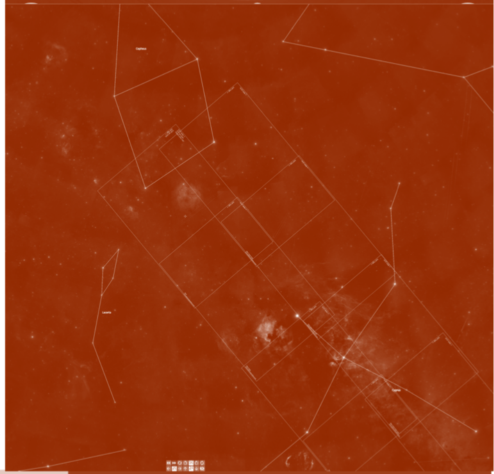
Choosing a Deep-Sky Object and Planning an Imaging Session

Nico Carver

AP-SIG Meeting

August 2018





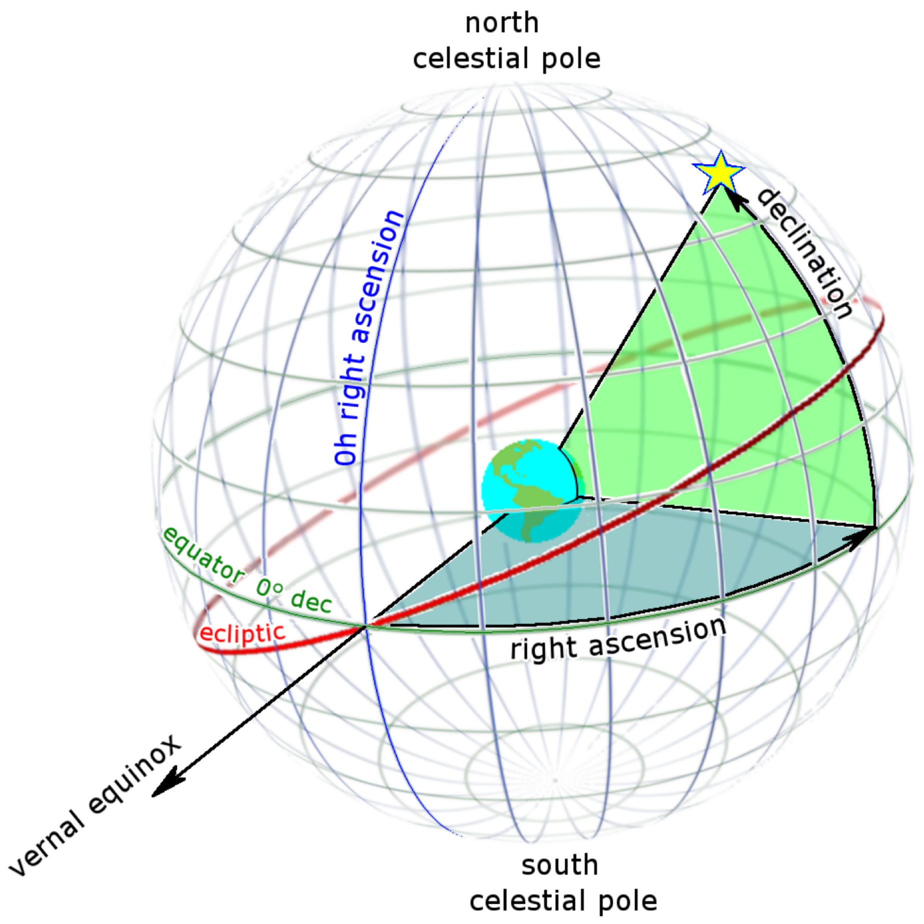
0	0	0	1.80	5	4	11 m/s	04.5	05.2	0.6 K	25°C	78%
0	1	0	1.81	5	4	11 m/s	04.5	05.2	0.7 K	25°C	81%
0	1	0	1.78	5	4	12 m/s	04.5	05.2	0.7 K	24°C	85%

Overview

- ❖ Choosing the right deep sky object for your location/date, sky quality, and gear
- ❖ Atlases, catalogs, surveys, web tools & planetariums
- ❖ An example of how I use the above to choose an object and learn about it to help me plan
- ❖ Pre-visualization and framing tools (print and electronic)
- ❖ Calculating ideal sub-exposure duration and minimum integration
- ❖ Astronomical weather forecasts
- ❖ Making the most of your location
- ❖ Extra considerations for those that use mono cameras and filters
- ❖ Gear setup and using an ordered checklist
- ❖ Successfully imaging over multiple nights

Choosing an object –location/date

❖ When looking for an object, the info that is almost always included is Right Ascension (RA) and Declination (Dec). It is very useful to have a basic understanding of RA and Dec. You can think of it as longitude and latitude except for the celestial sphere.



❖ Right Ascension will determine the ideal night to image a particular object. The ideal night will give you the most time with the object from object rise to object set. Declination will determine how high (how close to zenith when it crosses the meridian) the object will be in the sky.

❖ For example, if an object's RA and Dec read: **RA: 21h 20m Dec: 39° 48'** that would be the perfect* object for this location tonight meaning it would cross the zenith at solar midnight.

❖ Any object that is anywhere close to those values would make an excellent object. For example, North America Nebula has coordinates of: **RA: 20h59m and Dec: 44 ° 28'** It will be up most the night and pass within 5 degrees of zenith.

❖ Objects to avoid for our location will have declinations below **negative 20** ° meaning they will never get higher than 30 degrees in altitude. (90-40+-20=30). To image these objects well, we have to travel south!

Choosing an object –sky quality

- What we can call "sky quality" is mainly determined by the level of artificial light pollution. When the sky background level is raised due to light pollution, dim details in DSOs are much harder to capture.

- The best solution possible is to image under darker skies. The second best solution is to multiply the total integration by many factors (for example 20 hours integration vs 2 hours under dark skies). The third best solution is to filter the light to increase contrast. This works better for nebulae than galaxies and star clusters. The second and third best solutions can be combined to be even more effective.

- There are some very bright DSOs (e.g. M42, M45, M27, M31, M51, M8, M20) that will come out pretty well even under light polluted skies with minimal integration (1 hour or less) and one-shot color (OSC) cameras, but there is a limited number of these objects (see handout). Note: These could be considered beginner objects as they are the best ones to start with when first attempting DSOs, but they are also very beautiful objects that are great to continue shooting as you improve. (see handout for more info on these)





Choosing an object –gear (1/2)

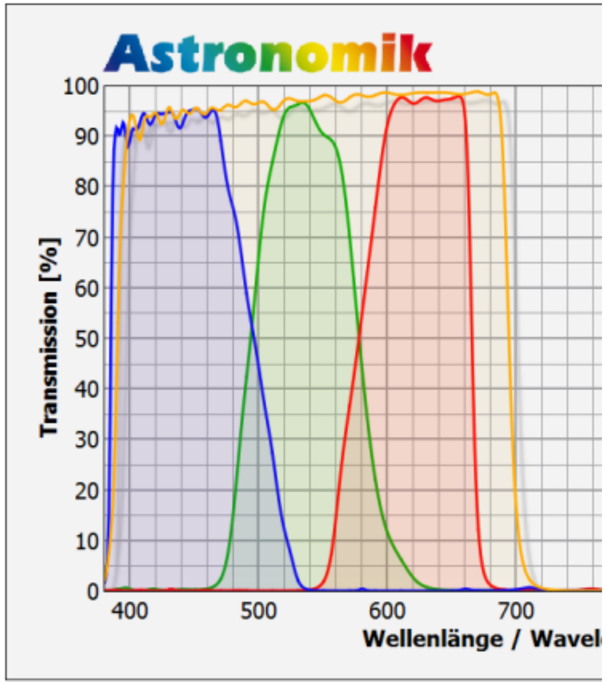
- ❖ Your gear determines your image scale (arcsec/pixel) and your field of view
- ❖ Field of view is key to choosing an object to image (example follows)

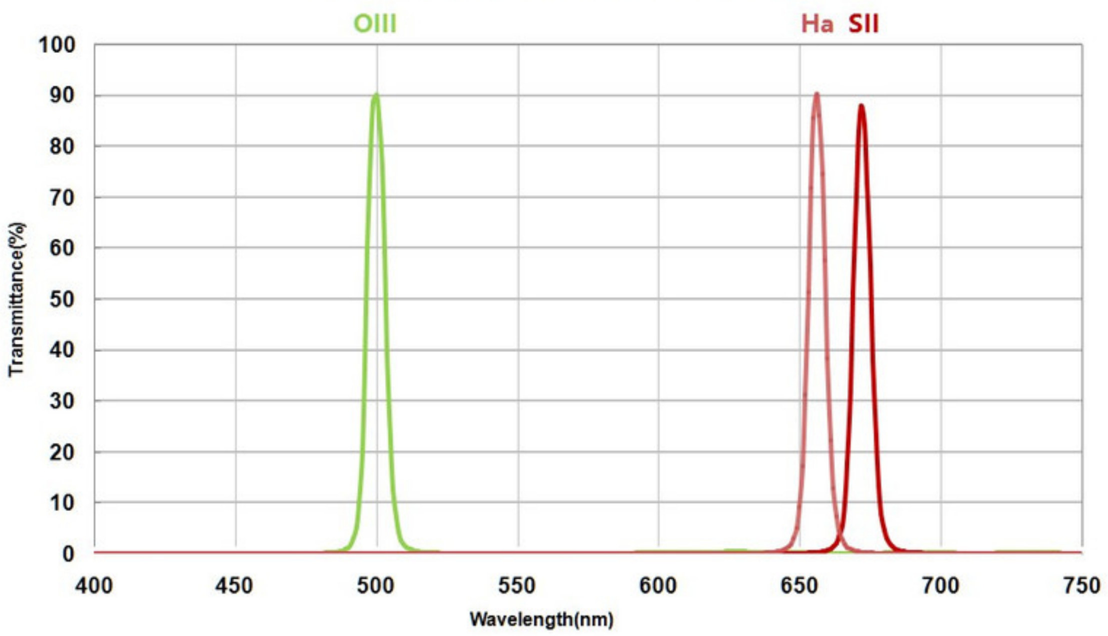
ZWO ASI1600 + GSO 12” (3.75µ pixels; 1219mm f.l.)

Canon 5Dm3 + SVQ86 (6.22µ pixels; 464mm f.l.)

Choosing an object –gear (2/2)

❖ All objects can technically be imaged in broadband (LRGB or OSC). Some objects (like emission nebulae, planetary nebulae and supernova remnants) are much easier to image using interference filters (LP, UHC, narrowband, etc.), especially when imaging under light-polluted skies. While a mono camera with a range of broadband and narrowband filters gives you the most options, similar results can be achieved with a OSC camera and a LP or UHC filter.





Best objects for broadband: Stars, Star Clusters, Galaxies, Galaxy Clusters, Reflection Nebulae, Dark Nebulae, Milky Way, very bright Nebulae (M8, M27, etc.)

Best objects for interference filters (LP, UHC, narrowband): Emission Nebulae, Planetary Nebulae, Supernova Remnants

Atlases, catalogs, surveys, web tools & planetariums (1/2)

How do I use these?

Atlases: browsing, choosing, framing, and star-hopping

Catalogs: finding new/rare objects, choosing

Surveys: framing and pre-visualization

Web tools: weather, browsing, finding new/rare objects, choosing, framing, and pre-visualization

Planetariums: browsing, choosing, framing, pre-visualization, mount interface

Atlases, catalogs, surveys, web tools & planetariums (2/2)

Which ones do I use the most for planning an imaging session?

Atlases: The Astrophotography Sky Atlas by Charles Bracken

Catalogs: Messier (M), NGC/IC, Sharpless (Sh2), Green's SNR (G)

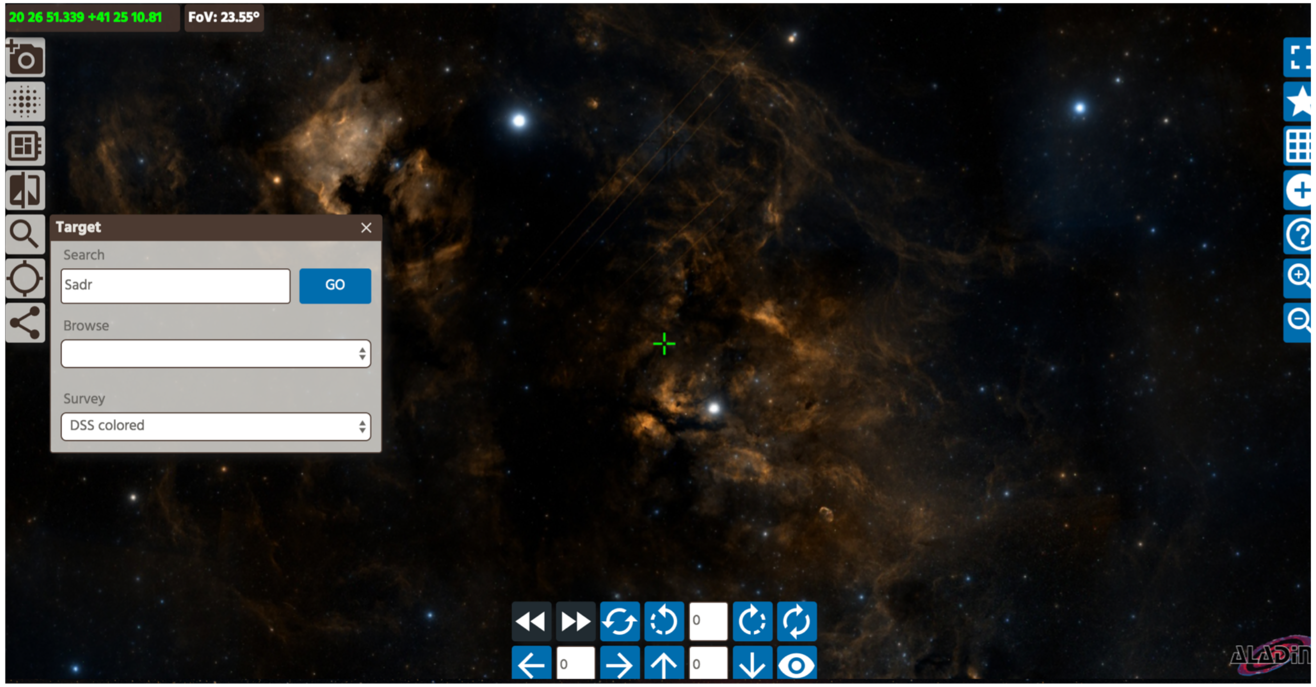
Surveys: Digitized Sky Survey II (DSS2) – can access with Aladin, KStars, etc.

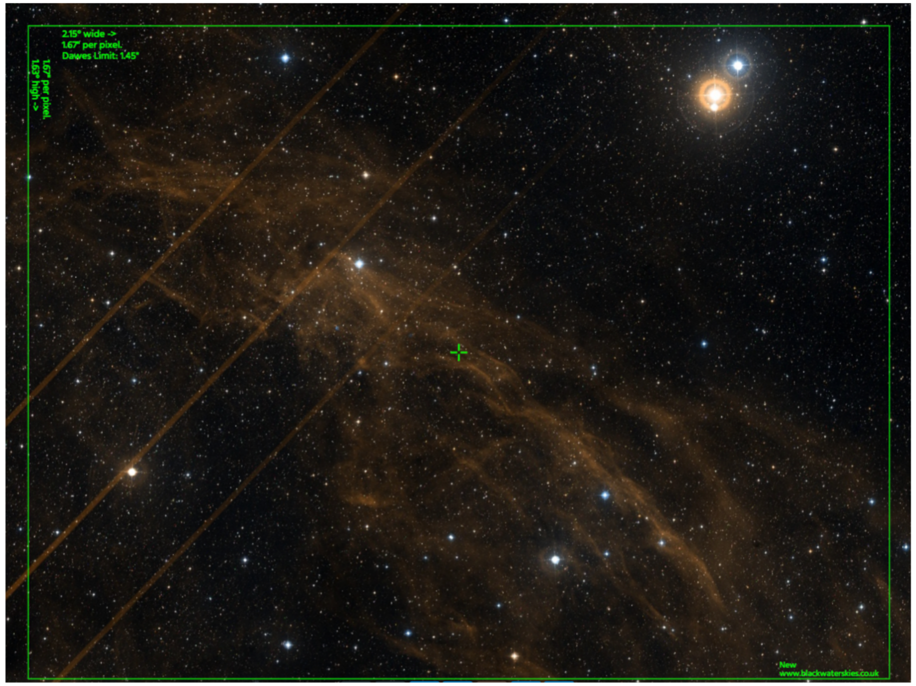
Web tools: Astrobin.com, ClearOutside.com, Blackwater Skies Imaging Toolbox, Astronomy.Tools, DSO-Browser.com, personal websites of astrophotographers

Planetariums: SkySafari Pro (smartphone), Cartes du Ciel, KStars

Example of planning workflow (1/4)

- I started with knowing I wanted something new to image in Cygnus or Cepheus this summer. So I pulled up the DSS2 survey imagery (I used [blackwater skies imaging toolbox](), but it is also easy to do with Aladin or KStars) and started browsing in that area. Zooming in and out to look at details and using the framing tool to see what fit in my FOV. (I initially was just going to try the one field below, but ended up deciding to try the larger 8-panel mosaic).



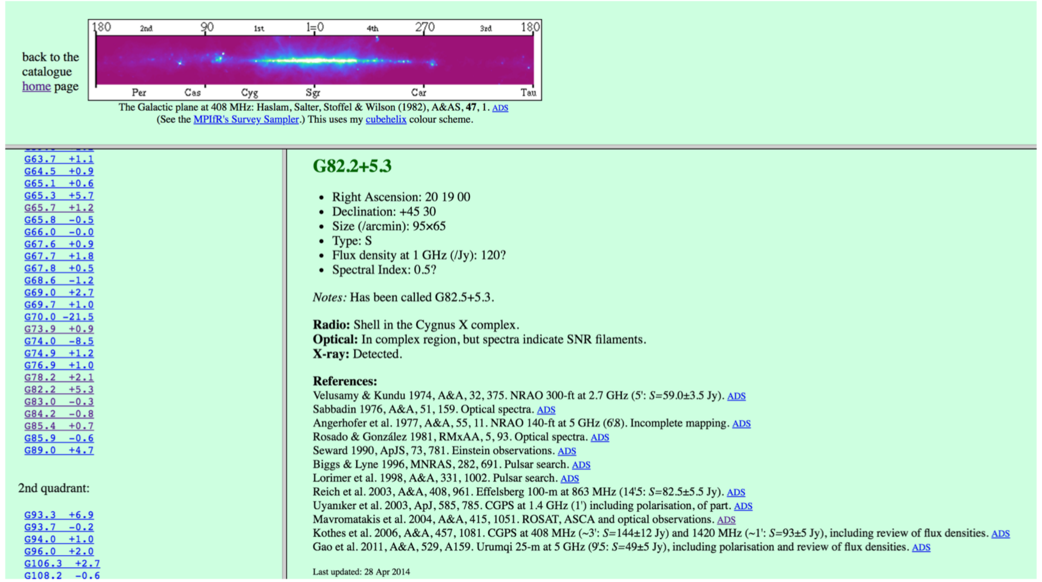


Example of planning workflow (2/4)

- Next, I tried to figure out if those filament structures had a name. I could not find them labeled in any atlas or planetarium. I started scanning through astrophotographers' web sites seeing if anyone else had imaged this part of the sky. I eventually found Robert Gendler had done a large (20 panel, 60 hour) mosaic in Cygnus that included an annotated version! This image inspired me to make a mosaic. I decided on 8 panels, as anything more seemed too ambitious to finish in one season. I also started researching this area in more depth now that I had some catalog numbers to work with.

Example of planning workflow (3/4)

❖ One catalog designation often leads to another as there are cross-listings. Many online catalogs also include references to the papers studying these regions. Some of these papers are very interesting to skim. For instance, I found out what the OIII signal in this region should look like from a paper, as I didn't see any amateur images of it. At this point, I decided I would do minimal Ha and RGB and as much OIII as possible. The problem is I wasn't sure what minimal Ha and RGB meant at this point.



back to the catalogue home page

The Galactic plane at 408 MHz: Haslam, Salter, Stoffel & Wilson (1982), A&AS, **47**, 1. ADS
(See the MPIfR's Survey Sampler.) This uses my cubehelix colour scheme.

G63.7 +1.1
G64.5 +0.9
G65.1 +0.6
G65.3 +5.7
G65.7 +1.2
G65.8 -0.5
G66.0 -0.0
G67.6 +0.9
G67.7 +1.8
G67.8 +0.5
G68.6 -1.2
G69.0 +2.7
G69.7 +1.0
G70.0 -21.5
G73.9 +0.9
G74.0 -8.5
G74.9 +1.2
G76.9 +1.0
G78.2 +2.1
G82.2 +5.3
G83.0 -0.3
G84.2 -0.8
G85.4 +0.7
G85.9 -0.6
G89.0 +4.7

2nd quadrant:

G93.3 +6.9
G93.7 -0.2
G94.0 +1.0
G96.0 +2.0
G106.3 +2.7
G108.2 -0.6

G82.2+5.3

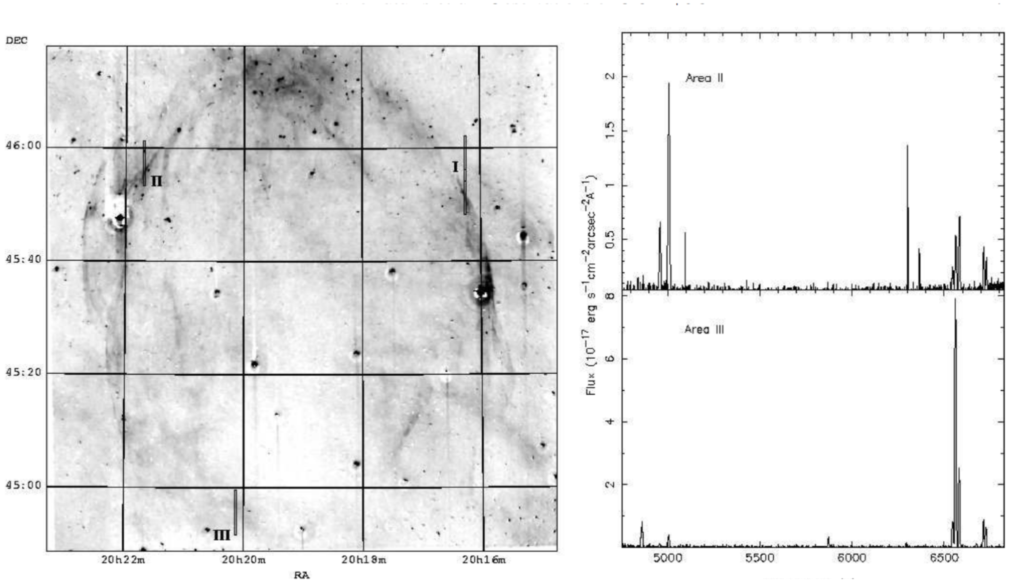
- Right Ascension: 20 19 00
- Declination: +45 30
- Size (/arcmin): 95×65
- Type: S
- Flux density at 1 GHz (/Jy): 120?
- Spectral Index: 0.5?

Notes: Has been called G82.5+5.3.

Radio: Shell in the Cygnus X complex.
Optical: In complex region, but spectra indicate SNR filaments.
X-ray: Detected.

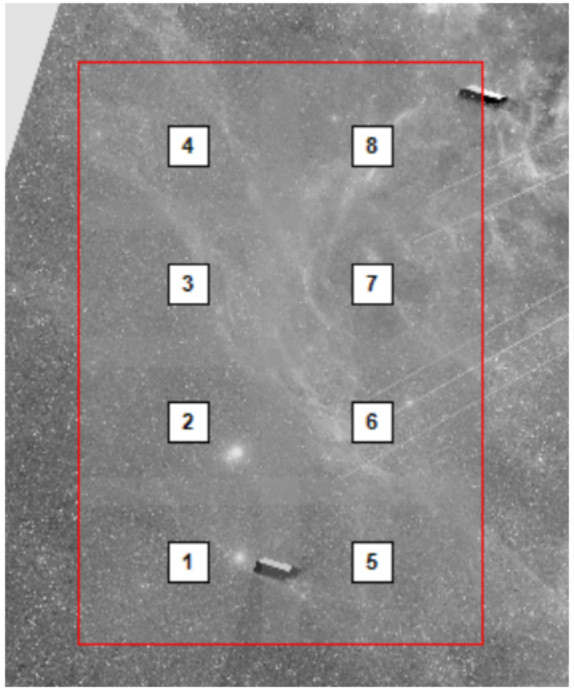
References:
Velusamy & Kundu 1974, A&A, 32, 375. NRAO 300-ft at 2.7 GHz (5': *S*=59.0±3.5 Jy). ADS
Sabbadin 1976, A&A, 51, 159. Optical spectra. ADS
Angerhofer et al. 1977, A&A, 55, 11. NRAO 140-ft at 5 GHz (6.'8). Incomplete mapping. ADS
Rosado & González 1981, RMxAA, 5, 93. Optical spectra. ADS
Seward 1990, ApJS, 73, 781. Einstein observations. ADS
Biggs & Lyne 1996, MNRAS, 282, 691. Pulsar search. ADS
Lorimer et al. 1998, A&A, 331, 1002. Pulsar search. ADS
Reich et al. 2003, A&A, 408, 961. Effelsberg 100-m at 863 MHz (14.'5: *S*=82.5±5.5 Jy). ADS
Uyanıker et al. 2003, ApJ, 585, 785. CGPS at 1.4 GHz (1') including polarisation, of part. ADS
Mavromatakis et al. 2004, A&A, 415, 1051. ROSAT, ASCA and optical observations. ADS
Kothes et al. 2006, A&A, 457, 1081. CGPS at 408 MHz (~3': *S*=144±12 Jy) and 1420 MHz (~1': *S*=93±5 Jy), including review of flux densities. ADS
Gao et al. 2011, A&A, 529, A159. Urumqi 25-m at 5 GHz (9.'5: *S*=49±5 Jy), including polarisation and review of flux densities. ADS

Last updated: 28 Apr 2014



Example of planning workflow (4/4)

- I then figured out exactly how I wanted to frame the mosaic with Sequence Generator Pro's Framing and Mosaic Wizard, and started taking some initial subs. After I had 15x5 min. HA frames in one panel, and 20x1 frames of R,G, and B, I integrated and did some quick processing to check what it looked like. I was happy with the RGB, but felt the HA could use more integration, so I decided to increase it to 25x5 min. HA for each panel. My plan (in progress) is to take as much OIII as possible starting with 20x10 min. on the panels where I know G82.2+5.3 should be. An early result of one panel in HaO3RGB below.

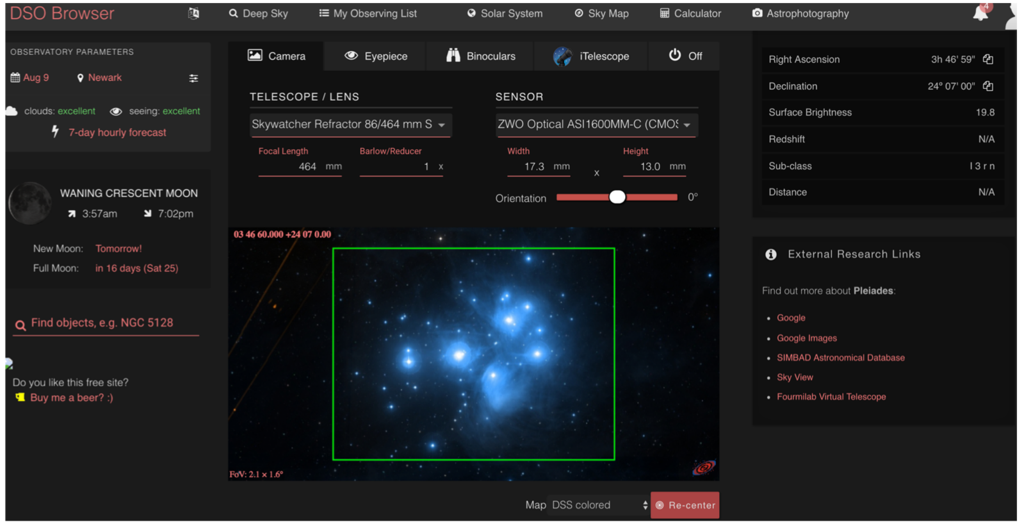


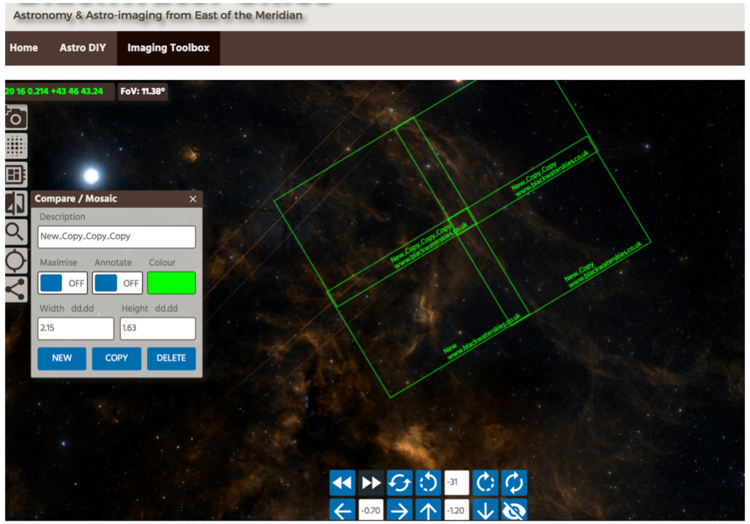
Panel 6
Ha: 2 hours
Oiii: 2 hours
RGB: 1 hour

Framing and pre-visualization (1/2)

All of the below tools use the Digitized Sky Survey (DSS2) which is great for pre-visualization since it is a photographic survey that used the same exposure lengths throughout the sky. So it becomes clear by visiting different objects which ones are very dim (barely show up) and which ones are very bright (blown out). All these tools also let you input your equipment or custom FOV to place an overlay on to the imagery and try out different framings by moving or rotating the field. Some also allow you to plan mosaics.

- [DSO-Browser.com]
- [Blackwater Skies Imaging Toolbox]
- Aladin
- KStars





Framing and pre-visualization (2/2)

- ❖ While the web tools and software mentioned on the previous slide offer many advantages over using a print publication, there are a couple reasons I still like using a print atlas for planning as well.

- ❖ To make a printed atlas work for me, it needed to do a few things:

1. Include many DSOs of interest to me (Sharpless, van der Bergh, dark nebulae, etc.)
2. Make an attempt to plot their size and shape

The only atlas I have found that does that is Charles Bracken's *The Astrophotography Sky Atlas*, which retails for around $30 new.

- ❖ In order to make quick decision on framing while using the atlas, I printed an overlay on clear transparency with some of the fields of view that I use most often.

- ❖ The main advantages of using print over digital:

1. Faster to rotate and move the overlay to try out different ideas for framing
2. Higher resolution while showing you more sky than the screen can achieve (without zooming)
3. Nice to take a break from screens and just browse through the atlas In a comfortable chair.

Sub-exposure length and minimal integration

- ❖ While there is a way to figure out the ideal sub-exposure length, it is a bit involved and requires making some measurements of the noise your camera creates and also measurements of the sky background. Sub-exposure length isn’t usually determined by the object except in the case of really bright DSOs. Why? usually stars clip well before the DSO, so the DSO isn’t the deciding factor.

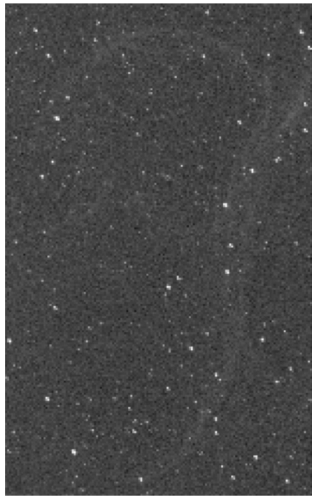
- ❖ Here is a simple rule of thumb for sub-exposure length that takes a little trial and error.
  - ❖ 1. Make sure your sub-exposure is long enough that the histogram bump has some separation from the left edge.
  - ❖ 2. Make sure your sub-exposure is short enough that only a few star cores are clipped (show up white when the data is completely linear (not stretched))

- ❖ Minimal integration is determined by how dim the object is. Brighter, popular objects will look okay after an hour or two. Dim, challenging objects need many multiples of that. Example on next slide.

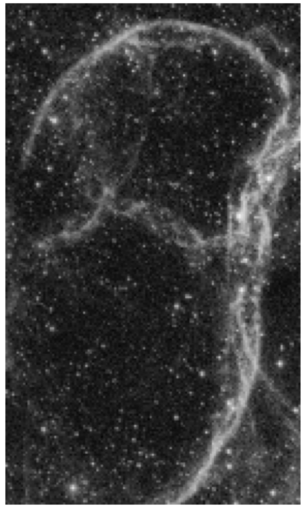
Example of change in minimal integration

1x
5 min

12x
5 min
(1 hour)



1x
5 min



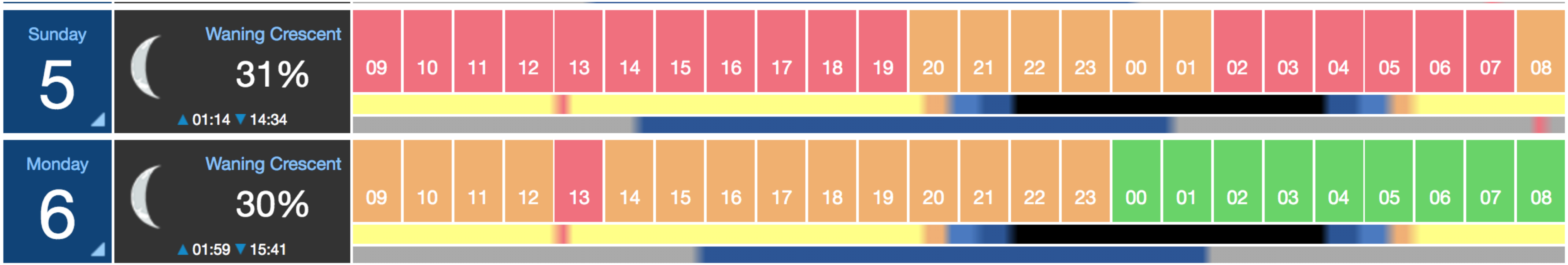
70x
5 min
(5.8 hours)

Astronomical Weather Forecasts

- I don't usually trust one forecast without confirmation from others. When I want to be really sure, I check many, and only setup everything when they all say 0% cloud cover.
- Here are the ones I use: Clear Sky Chart, ClearOutside.com, Weather Underground, NOAA, MeteoBlue, Astrospheric (app)

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

21	0	0	0	1.80	5	4	11 m/s	04.5	05.2	0.6 K	25°C	78%	--VMJS--P
22	0	1	0	1.81	5	4	11 m/s	04.5	05.2	0.7 K	25°C	81%	---MJS--P
23	0	1	0	1.78	5	4	12 m/s	04.5	05.2	0.7 K	24°C	85%	---MJS-NP

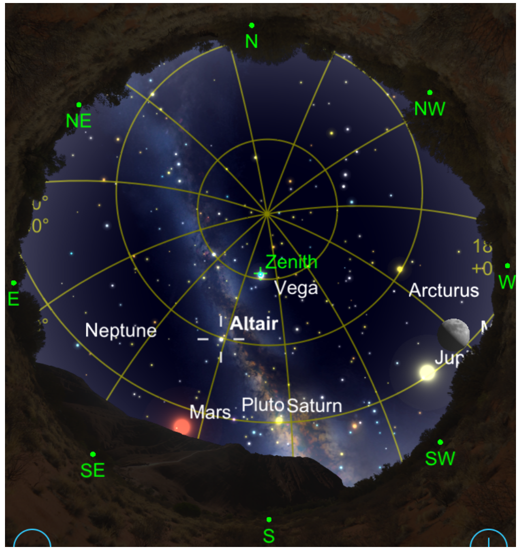


Making the most of your location

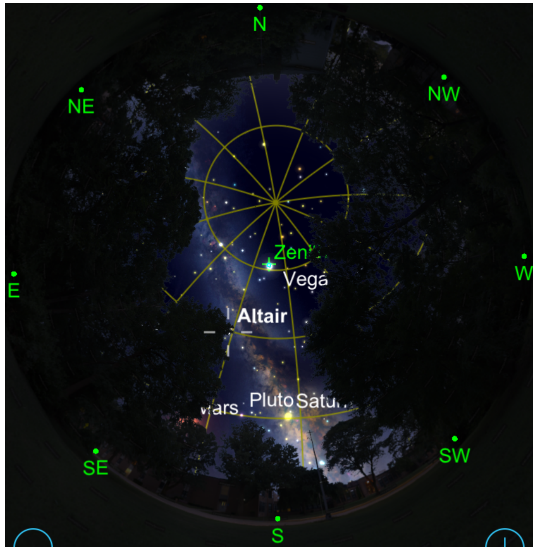
- Learning the objects in constellations, and getting to know your local horizons is a good way to figuring out ideal objects to image and when. For example, I know for my yard that Cygnus/Cepheus are well-positioned in the summer/fall and Taurus/Gemini are well-positioned in the winter/spring. This gives me tons of potential objects to image.

- An optional next step is to load your actual horizons (from a panoramic photo) in to a planetarium program. I have recently done this for Sky Safari Pro on my phone, and it is very handy to know when an object actually rises and sets considering the treeline.

Before

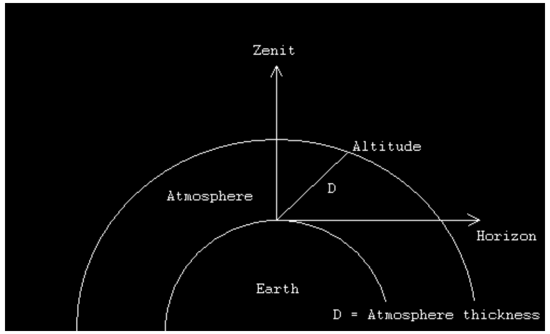


After



When using mono camera and filters

- The effect of atmospheric extinction (loss of light at lower altitudes) is stronger in blue light. It may make most sense to image through the red/Ha/SII filters when the object is lower (30-45 degrees) in the sky and green/blue/OIII filters when the object is higher (>45 degrees)



- Another school of thought is to rotate through your filters in a pattern like this: LLRGBLLRGB. The idea here is to make sure you are getting the right ratio of colors so you don't end the night with no blues for example. This approach requires an automated focusing system and ideally you need to set up filter "offsets" so as not to waste too much time.

- Narrowband imaging gives one many more usable night as I feel confident in shooting Ha and SII anytime. OIII doesn't work too well in Newark anymore due to the LED lights especially with any moonlight in addition. I only shoot OIII from Newark on moonless nights when the object is very high in the sky (>70 degrees).

Gear setup and using an ordered checklist

- For best results I have found it important to complete my setup in a very specific order each night. It therefore makes sense to use a checklist. Of course, having a permanent observatory would make this checklist much simpler. Here is an example of what mine looks like:

- [ ] Bring equipment to flat spot with views of object and Polaris
- [ ] Level tripod and add trays/spreaders
- [ ] Assemble mount: add pier extension, mount head, and counterweights
- [ ] Attach assembled imaging train (scope, camera, guiding) to mount
- [ ] Setup power and cables
- [ ] Rough polar alignment with polarscope (use iOS app: PS Align Pro)
- [ ] Balance Dec then Balance RA
- [ ] Turn everything on
- [ ] Start Cartes du Ciel and connect to EQMOD
- [ ] Start PHD2 and set up guiding camera (ASI290MM-Mini, RAW8)
- [ ] Start SGP and set up imaging camera (ASI1600MM-Cool)
- [ ] Run QHY Polemaster for fine polar alignment
- [ ] Run star alignment procedure in EQMOD
- [ ] Slew to bright star with Cartes du Ciel
- [ ] Center star with Lum filter and 1 sec. exposures in SGP
- [ ] Focus on star with Bahtinov mask and whatever filter I am using first
- [ ] Slew to target with SGP
- [ ] Center on target
- [ ] Plate Solve and slew again
- [ ] Center on target
- [ ] Run calibration (shift-click) in PHD2
- [ ] Start sequence in SGP

Successfully imaging over multiple nights

- ❖ Keep entire imaging train/ guiding setup/ etc. all attached together if at all possible. I have not removed or rotated my ZWO camera since I started the project in June.

- ❖ If working on multiple projects, use tape on the rotating part of the focuser to mark where it should be set.

- ❖ USE Plate Solving!! I resisted plate solving for a long time, because I thought it added complexity, and I wasn't sure I needed it. Now I understand that it is a huge time saver, and makes imaging over multiple nights way easier because you can be very precise with framing and rotation. If you use a laptop when imaging, I would suggest getting plate-solving working as soon as you have the other stuff working (tracking, focusing, guiding).

- ❖ Consider your focal length and whether gradients will be an issue.

- ❖ Variance in sky background level over multiple nights can be dealt with very successfully with PixInsight using weighting (SFS) or LinearFit.