

Canon-Nebulosity Tutorial for Beginners

by Kip Pauls & Arizona Dollar Bill Logan

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Eventually, we learned Nebulosity by asking a lot of questions on various astro-imaging groups. In an attempt to help others, we have written this little tutorial. Hopefully we have written it in an easy step-by-step guide. If we can understand it, you will too. Thanks to the work of John Armstrong, Michael Covington, Ed Hall, Michael Garvin, Craig Stark and many others for their support.

Although Nebulosity can be use with many cameras, this guide is specifically designed for those who have a Canon DSLR camera and Nebulosity for astro-imaging.

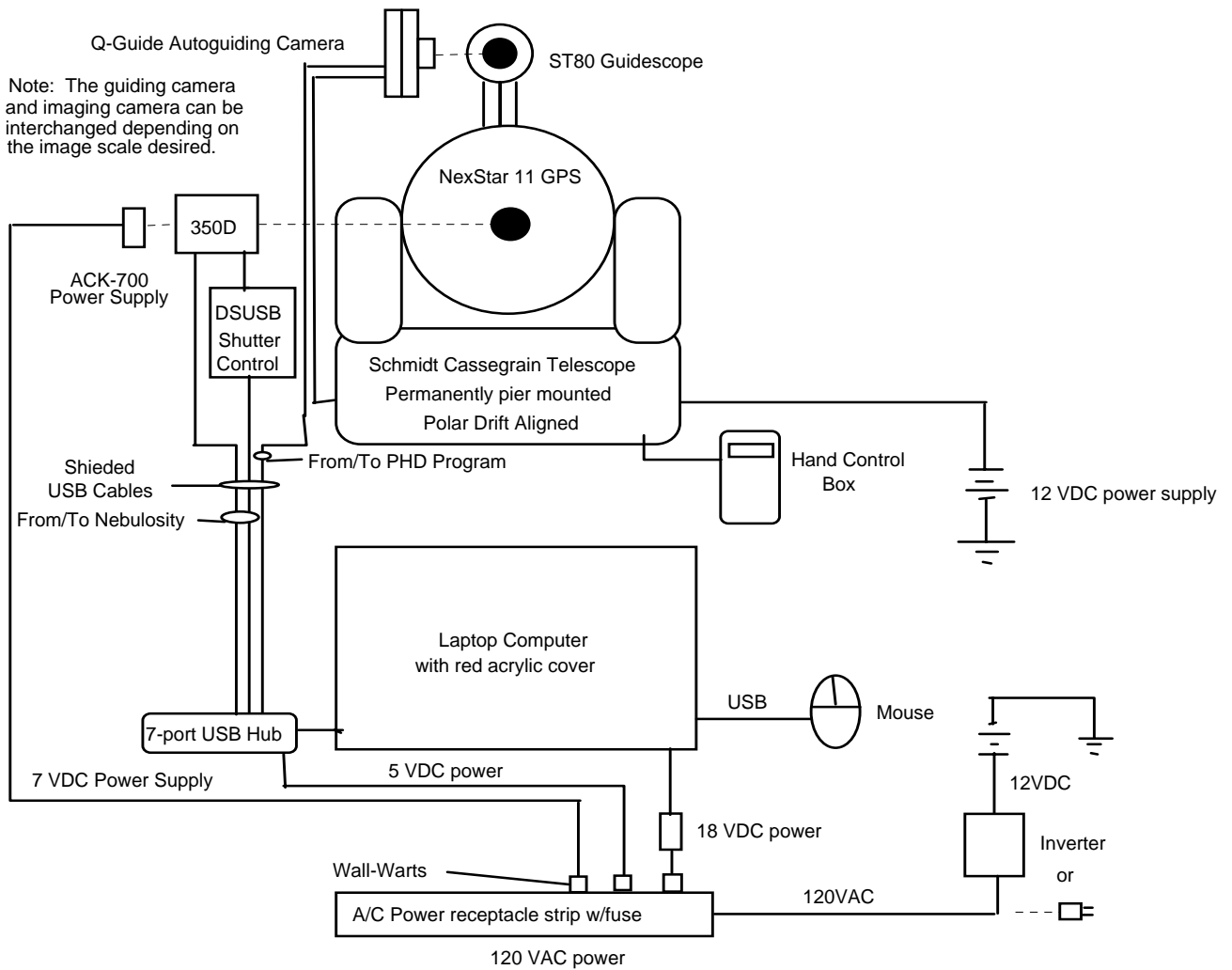


Diagram drawn by Arizona Dollar Bill Logan

A Typical Astrophotography Setup

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Before beginning, we highly recommend that you turn off any screen savers and adjust the setting for your laptop so that it won't automatically shut itself off for the lack of activity. We also recommend that you turn off any WIFI or internet connection while using Nebulosity. We have found that the laptop works best when it is dedicated to only Nebulosity and no other program except PHD autoguiding.

We will assume that you have your camera attached, A/C power supply (ACK-700) connected to the camera because long exposure photography will eat a NB-2LH battery in no time. You also have the Canon EOS USB cable connected to the computer and camera. You'll need a Shoestring Astronomy DSUSB cable or other suitable cable to control the shutter connected to the remote shutter control of the camera and the other end attached to the computer.

There is not much to Camera control as Nebulosity does all the work, but there are two things that you need to do before starting. Set the Canon EOS to "M" manual. Set the auto-off control to "off" otherwise the camera will turn itself off after 2 minutes leaving you scratching your head as to why it's not taking photos. Don't worry about ISO setting or image size. Nebulosity will control those items.

Important USB information: Some laptops only have one or two USB ports. This will present a problem for using all the USB controlled items such as the mouse, remote shutter control, autoguiding, and image capture and camera control. Newer laptops only have three or four ports which may not be enough. I humbly recommend that you purchase a 7-port "powered" USB hub. A laptop USB port only has 5VDC @ 500 mA. That will not be enough to power all the accessories.

On your laptop, I recommend that you create a folder to the target object. That will prevent any future mistakes during processing. If you're taking an image of the Trifid, make a folder in "My Documents," called "Trifid."

If the laptop is not already on, boot it up. Go through a checklist to prevent Murphy from ruining a night's imaging. Does my laptop have appropriate power to last the evening? Is the camera power supply plugged in? Is the USB hub power turned on? Shutter control cables connected? Camera control cable connected to the laptop? Red flashlight to see the keyboard? And the list goes on....

Capturing Images

Step #1: Turn on the Canon EOS camera. The Canon Utilities window will automatically open. Allow it to open and then click “Quit”. We found that if one tries to run Nebulosity with Canon Utilities open, you will get an error message. The two programs do not like each other. Now double click the Nebulosity icon. The Nebulosity window will open with a large black screen. Click the “Files” tab drop-down menu at the upper left corner of the window. Near the bottom of the list, click “Preferences.” Click “Acquisition Mode” and click the down arrow on the right and select, “RAW acquisition.” Next, click “DSLR Long Exposure Adapter.” Click the down arrow on the right and click “Shoestring DSUSB.” If you don’t select this option, the camera will only give you a maximum of 30-second exposures. Leave all the other settings alone unless you know what you’re doing.

Warning! If you do not make the necessary selections in the “preferences” section to RAW Acquisition, the Canon EOS will take the photos in JPG color format. Processing those images will be a daunting process. I know, the first time I tried to take images, I pulled my hair out for two days wondering why my laptop ran out of memory. Each of my carefully guided 30 images was an incredible 45.5 MB in size. To process that many images at the size, I would need a Cray computer!!

Step #2: On the right side of the screen under the “Camera” heading, click the down arrow for the drop-down menu. Select “Canon DIGIC II DSLR.” It will take a second or two for the computer and camera to shake hands. If a cable connection is bad or you simply forgot to connect the camera, you’ll get an error message.

Turn your telescope to a relatively dim star near the target. Please don’t try to focus on Sirius, Venus or other ridiculously bright object. You are now going to focus the camera, but you’ll need a star at about magnitude 7 or dimmer. It’s not like focusing the camera for a snapshot with auto focus (AF). Focusing a digital camera is a bit different than daylight snapshots. The CMOS in the DSLR is much more sensitive to light than your eye. We want the dim star to use as few pixels as possible. This will take some time and a lot of practice, but you will be rewarded with exceptionally sharp digital images if you will take your time with focusing. Craig Stark has made focusing very easy in Nebulosity. The pixel algorithm does all the work for you. All you need is a lot of time and patience.

Step #3: Focusing the camera. On the right side of the screen, under exposure>duration, select “1 or 2 seconds” or any short duration you feel is appropriate. (If the duration in parenthesis says, “(ms)”, go back to file>preferences> uncheck the box for “use msec not seconds.”) Leave Gain and Offset alone and leave the number of exposures to 1. Nebulosity will continue to exposure your focus star at the time you have selected until you press “Abort.” To get a rough focus, look through the Canon viewfinder and focus visually as best you can. Now press “Frame and Focus.” Don’t be alarmed at the image.

(Caution: If you see “dancing” stars, you are looking at hot pixels. Remove the lens cap dummy!! I know because I’ve done it!) When the image with nice stars appears, the crosshairs will be off-centered to the right. There’s two ways to get it centered. You can either use the “-“ for zooming out located under the histogram or you can use the sliders on the right side and bottom of the images until the crosshairs are in the middle. Once you have the crosshair centered, click “Abort”. Now click “Fine Focus”. The screen will do nothing. Don’t just stare at it. Look in the lower left corner of the screen. There’s a message for you. “Click on a star.” Select a dim star and click on it. The screen will suddenly go blank and your star will appear in the upper left hand corner along with three letters with numbers. M, m and S. (Note: If the window is too small, use the zoom-out feature under the histogram) “M” is for maximum pixel intensity; “m” is the average of three maximum pixels; and “S” is for sharpness. You can use any or all of these numbers to get a fine focus as they all increase when focus is best. I like using “M”, the top number because it has a larger range thus more sensitive. Turn the focus knob of the imaging telescope until you have acquired the maximum number. The “M” maximum that you can get while focusing is 65535. That’s why you don’t want to use Sirius or other bright star for focusing because it will always be at 65,535 regardless of your focus. Remember that we’re using a relatively dim star. It may never reach 65535. The object is to reach the maximum possible number. You will also have a running graph of each letter that shows you when you’ve achieved the best focus. Remember that we said focusing requires a lot of time? Here’s why. Each time you touch the focuser, the telescope moves causing the numbers to be very erratic hence the reason why some folks like to use moto-focusers. Allow the telescope to settle down and give you an accurate reading. These numbers will also be erratic when the seeing conditions are bad. Once you have reached the maximum numbers, tighten focuser set screws and then click “Abort.”

Step #4: Previewing your image live on the computer screen. Slew the telescope to your target object. Click “Frame and Focus.” I like to zoom all the way out so that I can see the entire field of view. With your telescope hand controls move the telescope so that the target object is composed in the center or wherever you want it. Remember that on some telescope/camera combinations, the edges will have coma (caused by having a flat CMOS surface that doesn’t coincide with a curved optics) so it’s important to center your target as best as possible. Once you’re satisfied with the composition, click “Abort.”

Step #5: How long should my exposure be? To start, change the exposure duration to 30 seconds and click “Preview.” After each image, look at your histogram. As Kip Pauls says in his Nebulosity tutorial, “Is all of the data to the far left? If so, your entire image is faint and you should increase your exposure. Let’s say you are trying to image the very faint Rosette Nebula. At 30-seconds, the histogram will show almost all of the data on the left. It wasn’t until I increased the exposure to 180 seconds (3 minutes) that I finally got a decent histogram. Ideally, you want a maximum signal on the left and gradually decreasing to the right. Exposure time is something you must experiment with. Remember that the longer the exposure and/or the higher the ISO number, the more hot pixels, the more noise you will have in the chip.

Gain - ISO setting. ISO is like the old ASA settings of film. The higher the ISO number, the higher the sensitivity which produces more grain (noise). By default, the gain will be set to level 4, ISO 1600. Personally, we like level 3 - ISO 800 providing faint details while keeping the noise down. It's a personal preference. Some like level 2 - ISO 400 while other prefers level 4 - ISO 1600. Experiment with different settings to your liking. The lower the level – ISO the less sensitive the CMOS and more exposure time will be required. The more exposure time; the hotter the chip becomes creating more noise. You have to find that happy medium of high sensitivity and low pixel noise. If you can keep the chip cool by applying dry ice to the camera, you can use higher ISO settings, but I would not recommend this practice especially in humid areas. Condensation is likely to enter the internal works of the camera causing possible damage. Newer CCD cameras are now coming on the market with Thermal Electric Coolers called TECs.

Offset: Leave the setting alone. It is automatically set by Canon EOS series DSLR cameras and should have been grayed-out.

Step #6: Taking a series of images. Well it looks like we're ready to image. First thing you need to do is tell the computer what the name of the object is and where will the RAW images be stored. Go just below the Abort button and give your images a name. If you are taking photo of the Trifid, get rid of "Series 1" and type in "TrifidRaw." (**Note: It is a good practice to change the name of your images at every step in the process just in case you want to go back and reprocess**) Just below that, click the "Directory" button and select the folder that you named previously, "Trifid." If you forgot to make a folder, click the "Make New Folder" button and under "My Computer" name it, "Trifid"

Let's say that you have determined the exposure time to be 60 seconds; you have decided to use gain at level 3 - ISO 800. Offset is set by the Canon DSLR camera and should have been grayed out. Set your number of exposures. We personally like 30 exposures for ease processing, but there's nothing wrong with trying 10, 20 30 60 or as many as you like. It is better to take 60 exposures at 30 seconds than to take 30 exposures at 60 seconds. Both are 1800 seconds (30 minutes) of data but 60 exposures at 30 seconds will have less chip noise. The important thing is to get as much data as possible. You cannot get enough data. Set your number of exposures. If you want to keep your CMOS chip cool, allow it take a break and select 60 second between exposures. This will also allow you to take a short break if you're manually guiding. For those who autoguide, this is the time to start your autoguiding program such as PHD. Select a star and insure that the telescope is going stay on the selected star during the time of capture. If you are ready and the autoguider is working well, click "Capture Series."

Step#7: Taking darks. Some people don't take any darks, flat or bias frames and have excellent images, but if your camera has been imaging all night, it is possible that the chip may have gotten some hot pixels. You may want to take some dark images to get rid of those nasty little hot pixels during processing. Place a lens cap on the imaging telescope. Change the number of exposures to 10 or 20. Change the name of the images to "TrifidDarks" and now click "Capture Series." The directory will stay the same until you change it. It's important to take your darks at the same exposure time and

temperature of your light frames. If you took 180-second exposures, then take 10 or 20 dark frames at 180 seconds.

Step #7: Now that you have all your data, it's time to process them. Suggestion: Do not attempt to process your images on the same night. If you're like me, you'll be fatigued. Taking digital images requires a lot of mental exercise. To get excellent images from your data, it'll take hours to process images taken with a large format digital camera such as the EOS series. Each of your raw images will be a staggering 15.5 MB. Files that big require a lot of processing time and you should have at least 1 GB RAM.

Processing Images

It is highly recommended that you do not process your images immediately after capturing. Capturing high quality imaging is mentally taxing. Before attempting to process your RAW images into a piece of art, get some sleep and start your processing rested. If you think capturing was exhausting, wait until you start processing.

Stacking Dark Frame. Power up the laptop and double click, "Nebulosity." When the window opens, check out the menus at the top. The first thing we want to do is combine your darks. You will use this process to combine your flats and bias frames also, however to keep things simple we will just do the dark frames. From the "Processing" menu, select "Align and Combine Images." A new window will pop up and you will have a choice of different alignment options. When stacking Dark, Bias or Flat frames you will press the "None (fixed)" button. Uncheck "Adaptive Scale Stack to 16 Bits." Uncheck this only when stacking Darks, Bias or Flat frames. Click "OK" and a window will come up. At the top of the window, be sure to find your folder "Trifid" that you made when you captured the images. Inside the folder, find your TrifidDark frames. Select all your Dark frames by clicking the first frame and then press "Shift + left click" the last Dark frame. All of your darks will now be highlighted in blue. Click "OPEN." The screen will now show you all of the dark frames as they are opened. If you see a box with a crosshair, close the entire program, reopen and make sure you press the "None (fixed)" button and try again. Once all the dark frames have been opened, a new window will appear. At the very top, make sure your Save-In "is the "Trifid" folder. Click the filename box and save your stacked darks as "DarkMaster" or whatever name you wish to give it. Now click "Save." The screen will blink and if you'll look at the very top, it will show the name of the newly saved file, "DarkMaster.fit" Congratulations! You have just stacked all of your dark frames.

Dark Subtracting. Now you are going to apply the "DarkMaster" to the light frames. Under the "Processing" menu, select "Preprocess B&W/RAW." At this time, don't be concerned with the Bias, Flat or Autoscale Dark. We're just going to do the MasterDark frame. Click "Dark" and select your "DarkMaster" that you just made, then click

“Done.” A new window will appear and ask you to select your light frames. As before, click the first light frame “TrifidRaw_001.fits” and at the last frame, press “Shift + left click” and all the light frames will be highlighted. Click “OPEN.” It will now dark-subtract all the frames and label them as “PPROC.” This may take a couple of minutes so it may be time to grab a cup of coffee or use the restroom.

Color Conversion and Squaring. A message will appear at the bottom notifying you that the images have been processed. The next step is to convert them to color and square the pixels. Under the “Processing” menu, select “Batch Demosaic + Square”. Now select all of the “PPROC” frames then click “OPEN.” As each image is being processed, Nebulosity will label them as “RECON.” Again, this will take some time so relax or find something else to do. Sometimes watching the process is about as exciting as watching paint dry or an apple turn brown. At about at this time, you probably wished that you had 2 GB of RAM!!

Now it’s going to get exciting. It’s time to stack! This is the best part and Nebulosity makes it so easy. From the “Processing” menu, select “Align and Combine Images.” The “Alignment/Stacking” window will pop up, but this time click “Save Stack” for the Alignment Method, select the “Translation” button. Time to pause here to explain the choice of options.

“**Translation**” means shifting (up, down, left, and right) only. This is appropriate if all your images were taken, one right after another, through, on piggybacked on, an equatorially mounted telescope.

“**Translation + Rotation**” means shifting and rotating. This is appropriate if your telescope was tracking in alt-azimuth mode or if you think the camera or lens may have twisted slightly between exposures.

“**Translation + Rotation + Scaling**” means all of that, plus stretching (changing size). This is rarely needed, but it might be appropriate if the image size of your telescope changes when you touch up the focus.

Make sure “Adaptive Scale Stack to 16 Bits” is checked. Click OK and a window will pop up. Select all of the “RECON” frames and then click “OPEN.” After the computer has retrieved all of the “RECON” images, the cursor will change to a crosshair. Use the zoom-in button so that you can see a close-up of the stars in the center of the frame. Your goal is to identify the same star on each good frame and delete bad frames from star movement especially if you have manually guided. If you have zoomed in enough, you can actually see the pixels of a dim star. Move the cursor over that star and click it. An hour-glass will appear indication that the image is being processed. When finished, you should see red circle around the same star making it easy to identify (if you selected Translation + Rotation, you will select the first star and when finished with all frames, will ask you to pick the second star located well away from the first star. When the second star is selected, there will be a red circle with an “X” on the first star. The second star will have a green circle). If you have good tracking, you can press Ctrl-Click to keep

the guess through all the frames. If you see a frame that has star movement, an airplane or a satellite, you can press “Shift + left click” to skip the frame. Time to take a break or mow the lawn or pull the weeds out of the garden as the laptop will now be doing some serious number crunching. When the stacking is finished, a window will appear and as before, name your object such as “TrifidStacked.” Be sure that it is being saved in the same “Trifid” folder. Press “Save.”

Now it’s time to bring out the detail. Under the “Image” menu, select “Adjust Color Background (offset)”. Don’t play with the sliders. Just click “DONE.” Again, this will require some number crunching so take another break.

Under the “Image” menu, select “Digital Development (DDP).” Our goal is an image that will be easy to process with PhotoShop or similar programs. At this point, we still have two problems:

1. The midtones are too dark relative to the rest of the image; that is, the image needs **gamma correction**.
2. Depending on whether they were stretched earlier, the pixel values may not use the full range (0 to 65, 535) of a 16-bit TIFF image.

A quick way to address both of these problems is called **digital development**. This is a combination of gamma correction and unsharp masking (sharpening). Digital development was invented by Kunihiko Okano. It is a rather quick algorithm to do what would otherwise be a multi-step process. In Nebulosity, the digital development algorithm usually works well with DSLR images. Just go to Digital Development (DDP), and let the algorithm do its work. We have had good results by simply pressing “Done.” Although the defaults are usually reasonable, you can further improve the image by adjusting the sliders; experiment with them.

Caution! Due to a bug in some Nebulosity programs, the sliders continue to sense movement after you release the mouse button. This can lead to confusing results. Immediately after moving a slider, do not move the mouse while the hourglass cursor is being displayed.

Now for a time-saving tip. Before selecting “Levels/Power Stretch in the next step, with the mouse, left click and hold down to crop a small portion of your image. During the Levels/Power Stretch, processing will only affect the cropped portion. At this point you probably don’t quite have a finished image. You can do some more stretching using the “Levels/Power Stretch” function. Under the “Image” menu, select “Levels/Power Stretch”. Some imagers suggest sliding the bottom slider left until you get a value of about 80. The middle slider should be moved about ¼ or 1/3 left. Finally, move the top slider to the apex of the histogram. This is where you can bring out additional detail and is the last step before post processing in a photo editing program such as “Microsoft Picture It!” or PhotoShop.

Examine the histogram. You want to have a nice curve that trails off to the right just before the left edge. Use the sliders to this. Remember the bug so keep the hourglass in the same position while processing. Save your image under the files drop-down menu. Select "Save JPG file as displayed" and "Save 16/bit color TIFF file." Now is the time to post process.

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