

Nebulosity

A certified "Best Buy" for
image capture and processing

A note from the editor: This article includes screen images that demonstrate various features of Nebulosity. Unfortunately, our print format is ill suited to reproducing the fine detail necessary to full appreciation of each screen shot. We wish to remind you that your current subscription to ATT includes ready access to the online version of every issue of the magazine. All images in this and the other articles of this issue are available there in high-resolution PDF. There you will also find additional screen images that compliment this article.

By David Snay

Readers of *Astronomy Technology Today* are likely familiar with Craig Stark of Stark Labs. He has previously contributed to *ATT*, describing the ins and outs of *PHD*, the autoguiding software that is available free on the Stark Labs web site, www.stark-labs.com. He is also the author of *Nebulosity*, a program that provides image capture as well as pre- and post-processing features for the very small price of \$45.

Nebulosity specializes in performing data capture and image pre-processing functions, such as alignment and stacking, with very high precision. It can also perform much of the fine-tuning functions required to produce a high quality image from all those photons you worked so hard to capture. *Nebulosity* uses 32-bit precision for all its functions in order to achieve more accurate integration of sub-exposures as well as calibration with dark, bias and flat frames.

In addition to providing a wide array of features, Craig has done a masterful job of documentation. I have used several processing packages and I can say without hesitation that the information in the help sections of *Nebulosity* is far superior to anything I have seen anywhere. The education on dark, bias and flat frame usage alone is worth the price of admission! Craig has also produced some very helpful "how-to" doc-

uments that reinforce the information in the help sections extremely well. These documents are available on the Stark Labs website as tutorials within the *Nebulosity* section.

The interface to *Nebulosity* is very clean and simple. All the tools you will need for image capture (and nothing you will not need) are on the main window and easily understood. Critical controls are located along the right side of the frame and there is also a status bar along the bottom that tells you what is going on while leaving the overall screen uncluttered. A quick tour through the documentation will make the screen layout even easier to understand, as well as reveal changes you can make to the appearance, but you can certainly start without any help on your first night out. Read the section on the Exposure panel and you'll collect even better data that is easier to manipulate later.

Nebulosity supports the FITS file format very well. All the data that I've grown accustomed to finding in the FITS header is still there. I am especially happy to find that both exposure length and CCD temperature are recorded, making it much easier for me to pick the appropriate dark frames for later use.

The set of features within *Nebulosity* is far too extensive to explore in the context of

one article. Besides, that would be tantamount to duplicating the help provided with the software. However, it is appropriate to review some of the features you'll likely use most frequently. I'll start with data capture tools and then move to image processing tools.

Data Capture

Craig has put together a set of tools that is very effective for data capture, while keeping to his desire to keep things simple to use. I used the full set to make an image of M48 on February 2, 2008, while the moon was shining brightly.

Select the Frame and Focus button in the Capture palette and you're presented with the screen shown in **Image 1** on the next page.

The first time I selected this option I was thrilled to see the crosshair. I have been struggling for more than two years to center images with the software that came with my imagers. The software I've been using doesn't show the entire image in the preview window (I still don't know why that is true.). To learn that Craig had the answer all this time was both a relief and humbling, as a little exploration on my part would have yielded this solution long ago. Now all I have to do is specify a short exposure duration, select this tool, and compose the

NEBULOSITY IMAGE CAPTURING AND PROCESSING



Image 1 – Frame and Focus Interface (Note the Crosshair Feature in the Main Screen Section)

image as I desire.

Once I had the cluster centered the way I wanted it, I exited the Frame and Focus tool and moved on to the Fine Focus tool as shown in **Image 2**. When you first select this tool, you need to specify a star to use for focus adjustment. In this image you

can see that the star I selected is still out of focus, even though it appeared to be in focus in the Frame and Focus window. As you improve focus, the star image will improve and the values shown will rise. There is a detailed description of the meaning of these values in Craig's documenta-

tion. You can use your eye, the values, or both, to fine tune your focus adjustment.

Once I had the image focused properly I then selected the Directory button in the Capture palette to specify where to save all files. I then entered a name to use for the prefix for all files for the next Capture Series. I was almost ready to start the series. One quick preview of my desired exposure duration and I would be ready to fire away. The status bar along the bottom of the window indicated that *Nebulosity* was taking one image in a series of one image, each at 120 seconds duration. It also told me that the percentage needed to complete the current image capture had been accomplished and that it was actively capturing data. If the series were complete, then it would have shown "idle" rather than "capturing."

Everything looked good at this point so I decided to go ahead and let it capture 15 exposures of 120 seconds duration each. After making that change, the status bar revealed the details of that longer series. Since working on this report, I have learned that I can change the display to show the current temperature of the CCD chip along the status bar, if that data is supported by the camera. That will prove very useful for ensuring the use of the correct dark frame.

When capture was complete, the status indicator changed from "Sequence acquisition" to "Sequence done", and "Exposing" and "Capturing" changed to "Idle." The middle section which showed "Exposing 15% complete" also indicated which file the data was saved to at the end of each exposure.

Image Processing

The first processing tool you should familiarize yourself with is the Grade Image Quality tool. This tool is ingenious. It measures all images in any given set for clarity against each other and assigns a grade to each of them. It can then either rename the existing files or make new copies with the appropriate names. The naming scheme is straightforward and easy to understand. Average quality exposures will be indicated with a value near "50" in the new name. Poorer quality exposures are assigned lower values and best quality will approach "100."

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This tool can remove much of the subjectivity from the process of choosing which exposures to use for the composite.

Once you've selected the images you want to use, it is time to calibrate them with whatever dark, flat and/or bias frames you choose via the Pre-process B&W/Raw Images or Pre-process Color Images tool. This process couldn't be simpler. You are presented with a simple pop-up that allows you to perform only the tasks you need. Select an option and you are presented with an interactive window where you can specify the calibration file to be used for the specified task, as shown in **Image 3**, and then another which will let you specify the light frames to use. Did I already mention that Craig provides an enlightening section on this aspect of the program that is well worth reading before you do any processing of your data? He does a very nice job of taking the mystery out of all three calibration tasks.

While I'm on the topic of dark frames, I want to share the results of a test I performed regarding *Nebulosity's* control of my Meade DSI-Pro II camera. Amp glow has been a constant problem for all users of this imager. There is a noticeable glow in one corner of all images above a short exposure and I assumed it was just something I had to live with. Well, was I ever wrong! I compared 60-second dark frames taken with the software that accompanied my imagers to those taken using *Nebulosity* and there is almost no comparison. The amp glow is virtually non-existent in the images taken via *Nebulosity*! (Comparison images are included at the conclusion of the online version of this article.)

I feel it is important to interrupt this demonstration to comment on the quality of dark frame calibration provided by *Nebulosity*. I have struggled with having dark frames produce the dreaded "brush mark" effect on many of my images ever since I started this wonderful hobby/obsession. I compared the results of my original tools with those of *Nebulosity* for this set of data. The brush marks were very obvious in my "normally" processed image, but completely absent in the image produced by *Nebulosity*. This is an amazing improve-

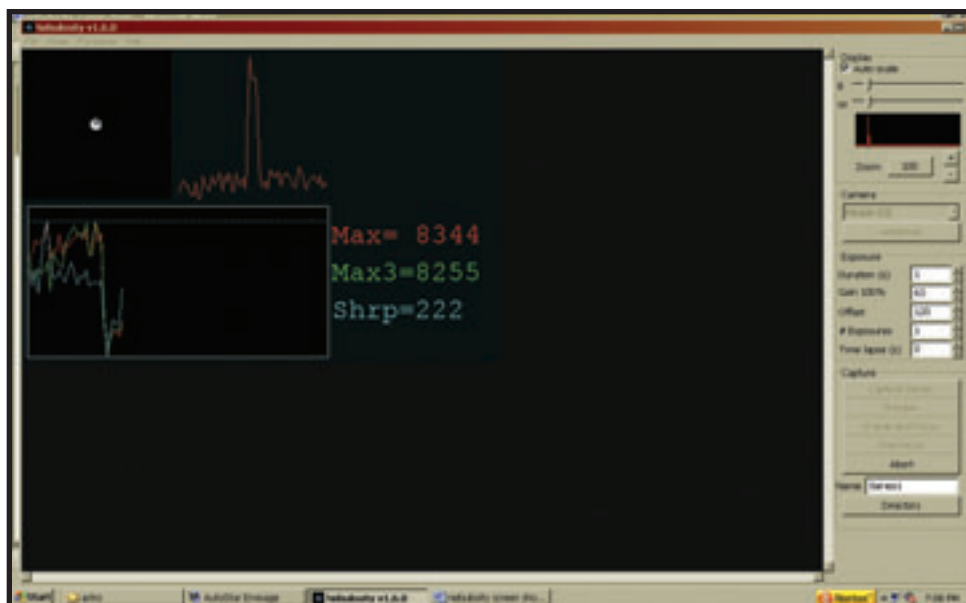


Image 2 – Fine Focus

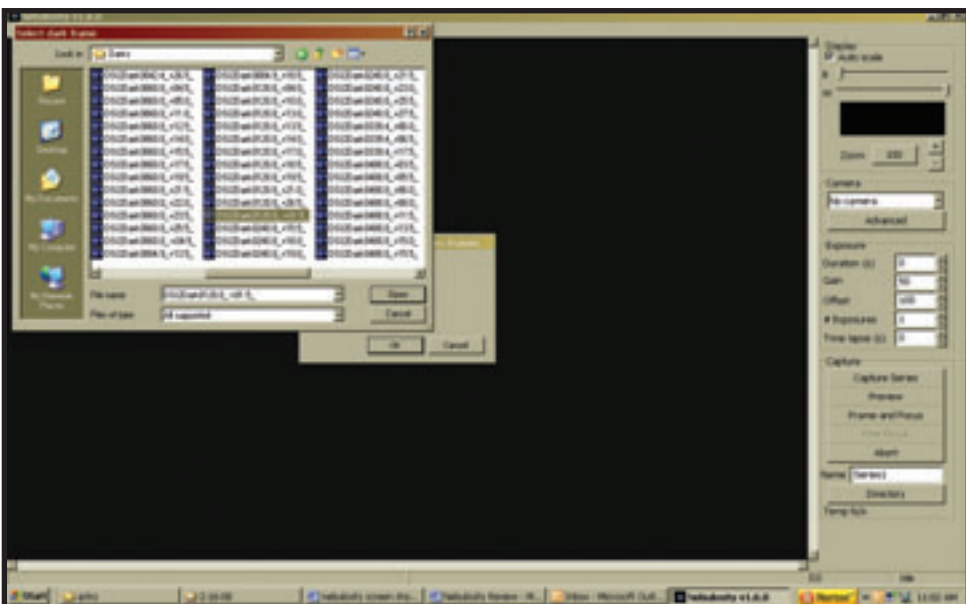


Image 3 – Select dark frame

ment over the software provided with my camera.

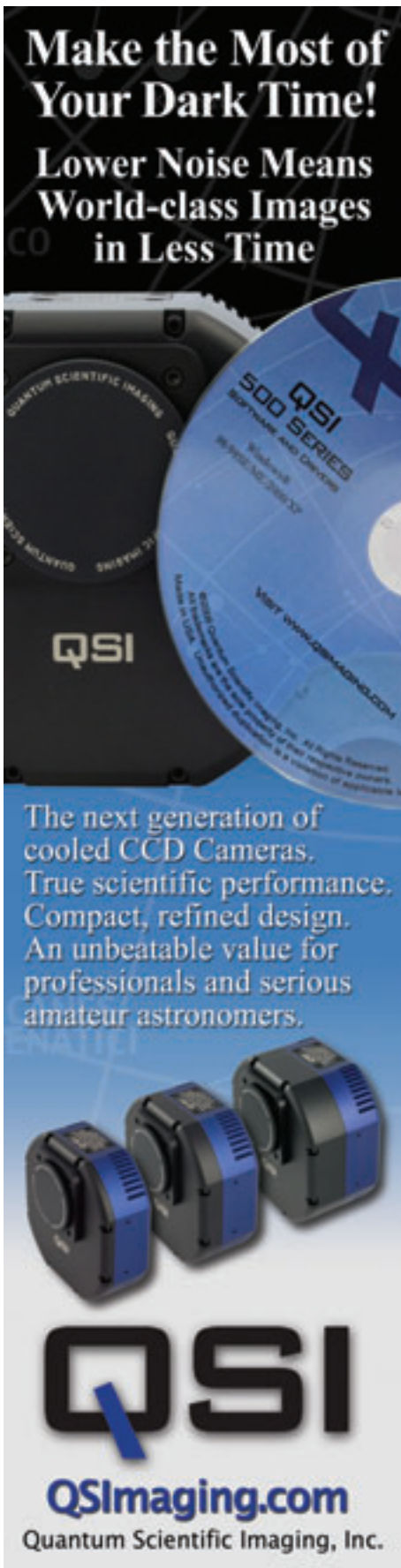
If you are using a one-shot color camera, you will need to "Debayer" the images using the Batch Demosaic + Square Raw Color tool before alignment. If you are using a monochrome camera with non-square pixels, then you will just need to square them using the Batch Square B&W tool. Both of these tools are found under the Processing tab.

The process of aligning and combining these pre-processed data files is also simple.

Nebulosity provides several methods for aligning the individual frames, ranging from simple one star (Translation) automatic alignment, all the way up to two star alignments with each frame fine tuned by the user. My testing showed a significant improvement in the shape of my stars when I used the two star alignment method, Translation + Rotation. This is because the one star alignment method uses only whole pixel adjustments while the two star methods use re-sampling to achieve finer adjustments. If your image frames are of slightly

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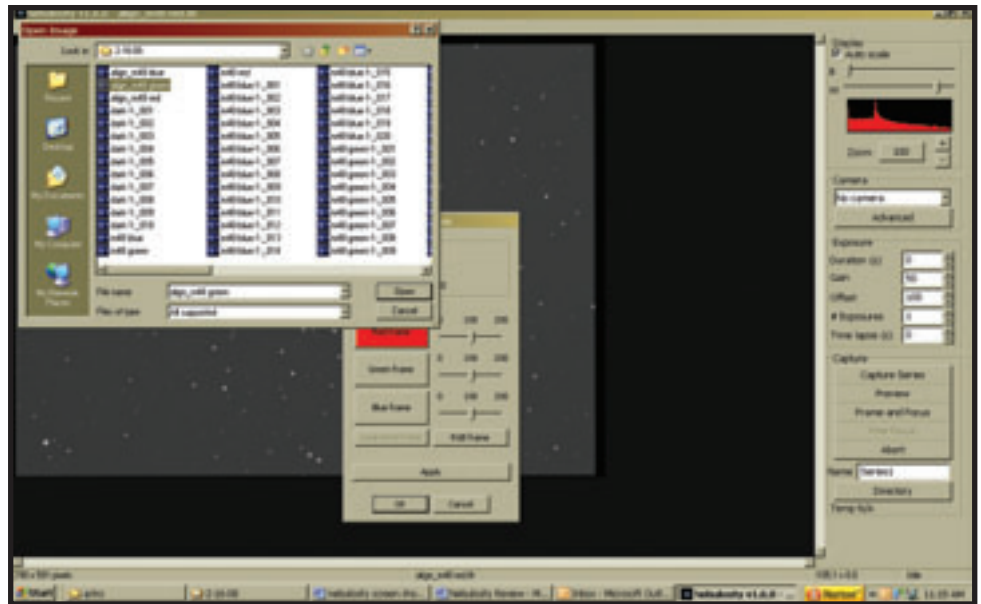


Image 4 – LRGB synthesis

different scales, you can also let *Nebulosity* track that, resample the frames, and adjust accordingly, to provide image frames of exactly the same size – just use the Translation + Rotation + Scale alignment option. The scale problem can occur when you use platforms like Schmidt Cassegrain Telescopes that shift the mirror when changing focus, as this alters the focal length of the optical path. You can also use the now familiar *Drizzle* process to increase resolution of image data.

I prefer the Translation + Rotation method as it allows for finer adjustment of each image as well as using two stars for alignment calculations. The process of alignment is extremely easy to use as *Nebulosity* shows one frame at a time. You indicate the first star to use as a reference point and *Nebulosity* cycles through all specified images using that star. The star being aligned in the first pass is circled in red and you can choose to verify each image or let *Nebulosity* assume it is correct without your input past the second frame. Directions are presented in the status bar. When the first pass is complete, you are then directed to select the second star to use for alignment. That star is circled in green and the first star now has a crosshair through the surrounding red circle.

If you are using a monochrome imager, you will need to merge your data sets to

form a color image. *Nebulosity* provides a very nice LRGB Color Synthesis tool for that which you will find under the Processing tab. With this tool, you can take the Luminance, Red, Green and Blue data sets and combine them to generate a color image. One of the nicest features of this tool is that you can specify the strength of each color in the resulting image, greatly reducing the effort required to balance the colors in later processing. *Nebulosity* provides the ability to preview the result before exiting the tool, a very useful feature. **Image 4** shows how the interface changes as you select the various files. The three color specific boxes start as grey and change to the appropriate color as you identify the file to be used for that color. In this case, I have already specified the red data and am now choosing the green data.

Now that you have completed all your pre-processing tasks, it is time for the rest of the work. All astrophotographers realize that the job has really only just begun at this point. No two images are exactly alike, nor do they require the same processing. However, there are some tasks so common that tools to accomplish them are essential in any image processing software package. *Nebulosity* includes these as a relatively small subset of its large set of tools. I'll only discuss the most common tools provided and leave the rest to the reader to discover

on the Stark Labs website and in the documentation included with *Nebulosity*.

One of the coolest tools Craig has devised is the Adjust Color Background tool. Using this tool, you are able to rebalance the colors a bit to accomplish most, if not all, of the task of removing background color, usually from sky glow introduced by light pollution. I experimented with this tool for several hours on one of my images and was unable to find settings that worked better than the defaults generated by *Nebulosity*. I don't know how Craig taught it to know what to do, but excellent work there! **Image 5** shows the result of this tool on my image. The difference is fairly subtle on this image but it really made the rest of the processing easier.

DDP was new to me since I do not have *MaximDL* or any of the other packages that include DDP mechanisms. However, a little Internet research left me believing that this is much like curves in *Photoshop*. DDP is probably the tool I have used the least in my experimentation to date. However, it did work fairly well on this image. I suspect this is one of those tools that either works great or not very well, depending on the data being processed. The data produced by my imagers did not seem to suit DDP very well. I really like what I can accomplish with curves, so I will probably continue using them for bringing out faint details. Of course, if and when I change imaging platforms, that may very well produce data for which DDP is the appropriate solution.

Power Stretch is very similar to the Levels function of *Photoshop*. The interface is quite different and my extensive background in *Photoshop* made using this tool initially harder to understand than it should have been. A quick email exchange with Craig and I was much more comfortable with the use of this tool. Much like other software, it pays to work the stretch in several small iterations rather than one big stretch. This lets the 32-bit processing algorithms work to produce the smoothest transitions across the tones within the image. Using this tool, I was able to bring out subtle detail in images of star clusters and bright nebula.

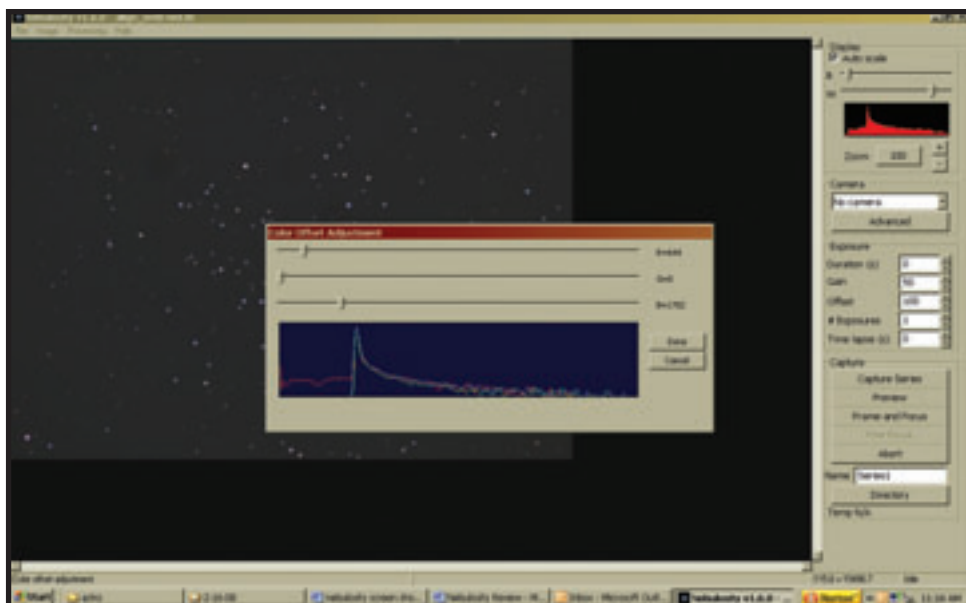


Image 5 – Adjust Color Background

The last image I will share with you is the finish product. **Image 6** on the next page shows the results of the previous steps and a very small amount of gradient removal and curves in *Photoshop*. The pre- and post-processing features of *Nebulosity* made the *Photoshop* process much simpler than it would otherwise have been.

Though I did not use them on this image, two more tools that I used quite a bit in my evaluation of *Nebulosity* are Adaptive Noise Reduction and Tighten Star Edges.

Adaptive Noise Reduction is very well implemented. It does a nice job of reducing background noise, particularly in images of star clusters. When used on images that have a nebula in them, the effect can detract from the nebula, which will require further processing to restore the nebula's impact.

This is not unique to this tool, as all noise reduction methods will reduce the detail within nebulas. Retaining and/or regaining that detail, or reducing the impact of noise reduction, requires a larger, far more complex processing package. Those packages will also make a much larger dent in your wallet.

Tighten Star Edges is a very useful tool for cleaning up the stars in your image. It is similar to the complex High Pass Sharpening procedure used by many astrophotographers when working in *Photoshop*. When combined with Adaptive Noise Reduction judiciously, the results can be that last piece to take your image from very good to excellent.

There are a great many tools included in *Nebulosity* that I have not discussed in this review. Some of them do not apply to

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Image 6 – M48

the monochrome imager(s) I use and others deal with processing aspects I simply have not had time to investigate further.

Who Can Use Nebulosity?

Nebulosity runs natively on both Mac and Windows platforms, unlike most of its competitors. You will need to download the software package for each platform, but there is only one purchase transaction. The fact that it runs on Mac should be welcome news to many Mac enthusiasts out there looking for a way to capture astronomical images.

Many applications support only cameras from one manufacturer. *Nebulosity* supports image capture on a large list of imagers, including webcams, SBIG, Meade, SAC, Atik, Artemis, Starlight Xpress, CCD Labs, QHY Astro, Fishcamp, Orion, and Canon, on Windows. The current list for Mac is SBIG, Meade, Starlight Xpress, Fishcamp and Canon, with CCD Labs following soon. At this time, there is no support for webcams on the Mac. This is an impressive list of available configurations and Craig is continually adding to it as demand warrants.

Conclusions

At first, I was looking at *Nebulosity* as a replacement for my entire current image processing software, which is comprised of Meade's *Envisage*, Autostar Suite Image Processing, *SGBNR* and *Photoshop*. In hindsight, that is a pretty tall order. That's also not the goal of *Nebulosity*. *Nebulosity* strives to provide us with a tool that, in

Craig's words "gets you to the point where you'd pull your spouse or kid over and say, 'Hey, look what I got last night! It still needs to be cleaned up, but look!'" In my opinion, it does that very well.

In typical end-user fashion, I opened up the software and started plunking around the menus trying to make images comparable to the ones I have generated using the aforementioned list of programs. Needless to say, I was less than successful.

Then I put on my reviewer's cap and decided to read the manual. What a novel idea! I know I have commented on the quality of the documentation before, but it is worth repeating. Craig's document is award winning caliber material. After reading the documentation, I was able to make much better use of the tools. Craig has produced some online examples of how to make best use of the tools which can be found on the Stark Labs web site and should be considered integral to the documentation.

In addition to the documentation, there is also an online user group for all of the Stark Labs software located at: <http://tech.groups.yahoo.com/group/stark-labs-astronomy-software/>. The group is pretty active and Craig is a regular contributor. I wandered through the posts there and it is clear he is genuinely interested in making the product the best it can be.

The strength of *Nebulosity's* image processing lies in the pre-processing tools. It does a very nice job of producing excellent data files, which can be used to generate astronomical images. If you don't already have one of the big, expensive packages, *Nebulosity* can produce full color images that you can be proud of. They may not be the equal of those produced using *Photoshop* and/or *MaximDL*, but you will have a significantly fatter wallet.

So, after several months of tinkering with *Nebulosity*, moaning about the lack of clear skies and pestering Craig with endless questions, I have settled on the following general workflow.

Nebulosity:

1. Capture image sub-exposures in FITS format.
2. Calibrate all images with appropriate dark/flat frames.
3. Align/combine each color set and save each in one FITS file.
4. Align the resulting files with each other.
5. LRGB merge them.
6. Adjust Background Color.
7. DDP or Power Stretch – whichever works best for a given set of data.
8. Save the resulting image as 16-bit TIFF file.

Photoshop:

9. Import the color image.
10. Perform fine tuning to taste.

Nebulosity (if needed):

11. Adaptive Noise Reduction.
12. Sharpen Image_Tighten star edges.
13. Done!

Given that *Nebulosity* is intended to compliment packages such as *Photoshop* and *MaximDL* rather than replace them, I would say that Craig has exceeded all expectations. In fact, it will likely replace my current pre-processing software as I feel it does a better job of dark frame subtraction and sub-exposure combination than the software that came with my camera. Have I mentioned how much I like the Adjust Background Color tool? You have to try it if you live in a location with light polluted skies (don't we all?).

I have used *Photoshop* for more years than I care to admit for production of digital versions of my Fine Art Black & White photographs and it must remain part of my daily routine. Therefore, I will likely continue to use *Photoshop* for the bulk of my post-processing work. That being said, there are many experienced astrophotographers producing very nice images using *Nebulosity* from start to finish.

In my opinion, *Nebulosity* can be a very valuable part of any image processing workflow. Combine that with the pre-processing education contained in the documentation and you have a certified "Best Buy" in *Nebulosity*. ■■■