Combining Photos with DeepSkyStacker

This freeware makes stacking your deep-sky images a snap.

JERRY LODRIGUSS Among the list of important equipment required to produce pleasing images of the night sky, powerful stacking software ranks nearly as high as the camera and telescope you'll use to take your images. But with the many choices available today, which program gives you the biggest bang for your buck? Perhaps the answer is *DeepSkyStacker*, at least in the money department. The processing package won't cost you a dime and can help you produce excellent results.

DeepSkyStacker (**deepskystacker.free.fr/english/index.html**) is a PC program for CCD or DSLR imagers that provides the means to align, calibrate, and stack a series of individual deep-sky exposures into a final smooth result, ready to be stretched and sharpened in any photo-editing program.

Written by Luc Coiffier, the program is reasonably simple to use, but its many actions and settings can be daunting for beginners. It also has some surprisingly sophisticated features for more advanced users. Here I'll cover the basics to get you started.

Understanding Stacking

The universal method for deep-sky astrophotography today is to shoot a series of images of your target and then to combine (or stack) the results to produce the equivalent signal-to-noise ratio of a much longer exposure. Higher signal-to-noise ratios produce smoother images that can be "stretched" to bring out faint details in nebulae and galaxies.

Before images can be aligned and stacked, they should be calibrated first (see the April issue, p. 66). Most photo-editing programs will not perform this very important step.

A series of long-exposure deep-sky photos tends to have some unintentional, and sometimes intentional, movement between frames. Unintentional movement can come from causes like imperfect polar alignment or inaccuracies in the mount's gear train. Even with perfect tracking, having some movement between frames is often a good thing. Indeed, many experienced astrophotographers will often intentionally move the mount a little bit randomly between exposures in a process called "dithering" so that pattern noise in the sensor is averaged out in the final stacked image.

Whatever the cause, if you shoot a series of long-exposure images, the stars will most likely not line up once you stack the frames. Stellar alignment and stacking are the functions that *DeepSkyStacker* excels at.

To align a series of exposures, the program identifies reference stars common in each frame. It then shifts and rotates the individual images so they align with this reference frame. *DeepSkyStacker* then combines the aligned

STACKED Deep-sky astrophotography in this age of computers and digital cameras is easier than you might have thought. *DeepSkyStacker* allows you to calibrate, align, and stack all your images to produce smooth results with low noise that can then be processed in your favorite photo-editing software, like this image of van den Bergh 14 and 15. All photos courtesy of the author.

frames into a single result with a drastically improved signal-to-noise ratio. And this is all done automatically!

Learning the Basics

To get the most out of your data in *DeepSkyStacker*, start with reasonable-quality images that are properly exposed, focused, and tracked. The program will have trouble aligning images if they're not.

If you're shooting with a DSLR or mirrorless interchangeable lens (MIL) camera, it's important to shoot in RAW mode. It's also helpful to record your images with the correct color balance, especially if you're using filters or have a modified camera. For example, when using an unmodified camera — one that still has its factory-installed infrared-blocking filter — set the white balance to "daylight" or direct sunlight.

When shooting with a modified camera, or through light-pollution filters, you'll get your best results if you create a custom white balance by shooting a gray card illuminated by the Sun at noon on a clear day. Refer to your camera's manual to find out the specifics of how to set a custom white balance.

Exploring the Settings

The first thing you should do after opening *DeepSkyStacker* is to go to the left-hand column in Options > Settings > Raw/FITS DDP Settings ❶. Most can be left at their defaults, though if you shoot with a DSLR or MIL, you'll need to change the settings in the RAW tab.

If you shoot RAW images with either a stock or modified camera using an appropriate white balance (daylight for stock, or a custom white balance with a modified cam-

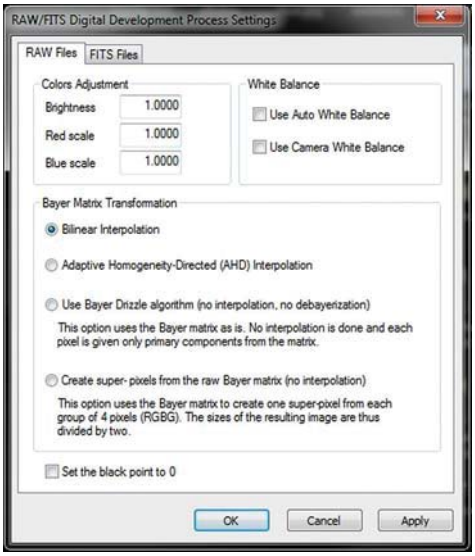
era or any camera with a filter), check the "Use Camera White Balance" box. When shooting with any other white balance settings, check the "Use Auto White Balance" box. Leave the "Set the black point to 0" box unchecked, even when employing bias calibration.

Note that the RAW/FITS DDP Settings apply to RAW and FITS files only; Auto White Balance will not work with JPEG images. If you did shoot in JPEG mode using daylight color balance, you can stick with the default settings. If not, you'll need to change a setting in the Light frames tab later just before stacking.

CCD imagers should select the FITS files tab. Color-camera users should check the first box and then select your camera or CCD detector from the Camera drop-down list. This setting determines the Bayer pattern used by your particular camera and is used to accurately convert the color filter array's monochrome data into an RGB color image. You'll find many other optional settings buried deep in the program, but in most cases, the defaults will work fine.

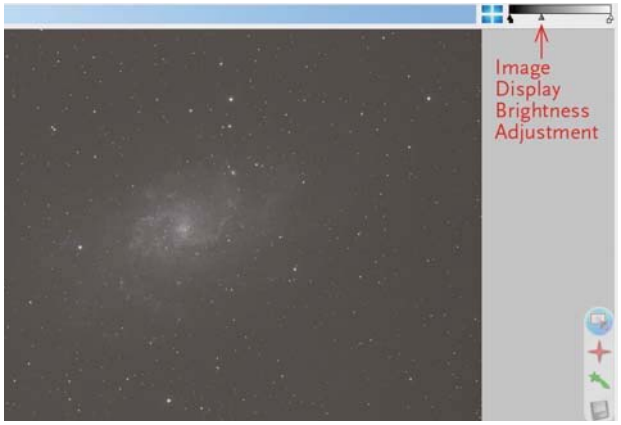
Now let's open the images. The first time you click the Open picture files command in the left column of your screen ❷, the "Open Light Frames" window appears, but you won't see any RAW-format images listed. Change the "Files of type" selection from Picture Files to All Files, and you should be able to select all your images.

Next, open your calibration files in each group ❸ by clicking the corresponding command (dark files, flat files, dark flat files, and offset/bias frames). Make sure to click "Check all" ❹ so that each group will be used when calibrating and stacking the results. The open image groups are then sorted in the bottom column of your screen, with a summary including the number in each group.



COLOR SETTINGS *Above:* The first thing to do in the program is to click the Raw/FITS DDP settings and choose the correct white balance setting for how you imaged your target.

COMMAND BAR *Left: DeepSkyStacker*'s main user interface is located in a column along the left side of the screen. Important actions detailed in this article are numbered in red.

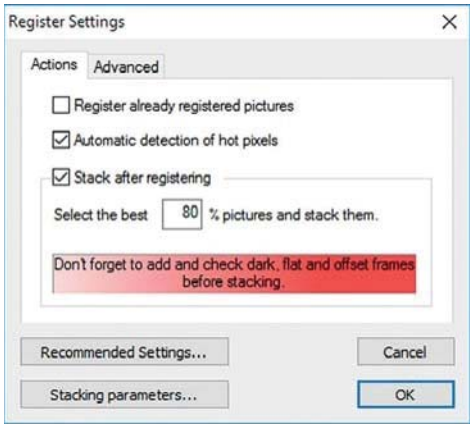


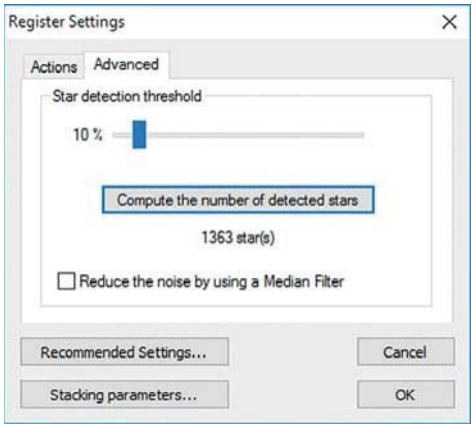
BRIGHTNESS ADJUSTMENT Most unprocessed deep-sky images appear very dark with a smattering of stars across the field. You can adjust the displayed brightness of your image by sliding the middle caret to the left. This only changes how the image is displayed and does not modify the saved photo.

To begin processing your photos, right-click on the first image file in the list at the bottom of the screen and select "Use as reference frame." This chooses which image all the others will be aligned to, and it also opens a preview of the photo. Besides a few of the brightest stars in your photo, the image will usually appear very dark on your screen, because deep-sky targets are much fainter than the stars in a linear image. You can adjust the display using the sliders in the upper right corner of the window. Move the middle caret to the left to brighten the image. Don't worry: this adjustment only changes the display and does not actually modify the image.

Your next step is to click the "Register checked pictures" command ❺. When the action window opens, click OK to accept the default settings, and *DeepSkyStacker* will combine the best 80% of your images. You can change this to 100% if you prefer to use every image. You can also adjust the number of stars used to align the frames with the Advanced tab if the program is having trouble aligning your frames. Move the slider to the right to detect fewer stars. *DeepSkyStacker* requires a minimum of eight stars and at most a couple of dozen to work. When you're ready to move on, click OK, or cancel and click the "Stack checked pictures" command ❻.

At this point the Stacking Steps window opens, and there you can double-check all of the settings. If you shot JPEG images with a custom or incorrect color profile, select the Stacking parameters button and choose the Light tab. Now click the "Per Channel Background Calibration" line and check the box next to RGB Channels Background Calibration. If everything else is as you've





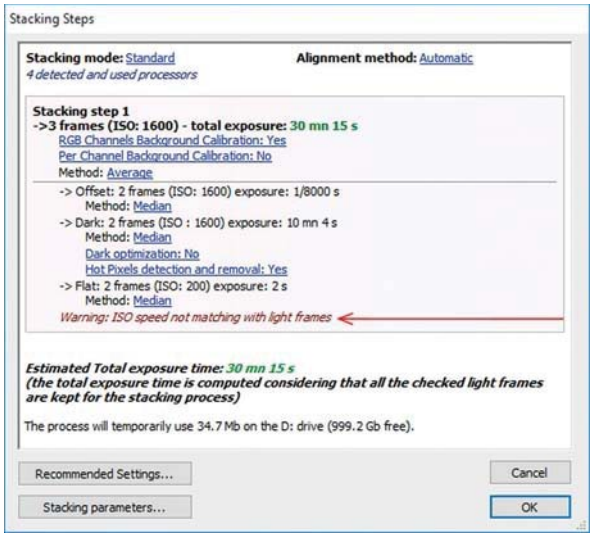
MORE OR LESS *Far left:* The Actions tab in the Register Settings window allows you to change the percentage of images used in the final stack.

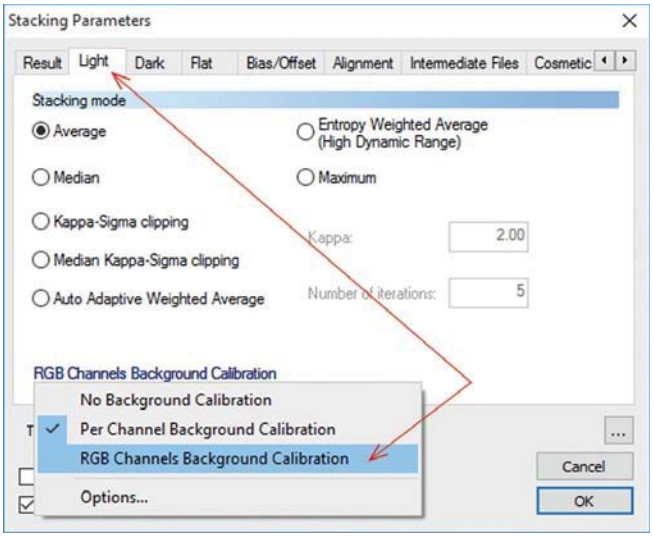
STAR DETECTION *Left:* Although the default settings often perform without issues, if your stacked result didn't properly register your images, you can adjust the number of stars *DeepSkyStacker* examines to refine its registration.

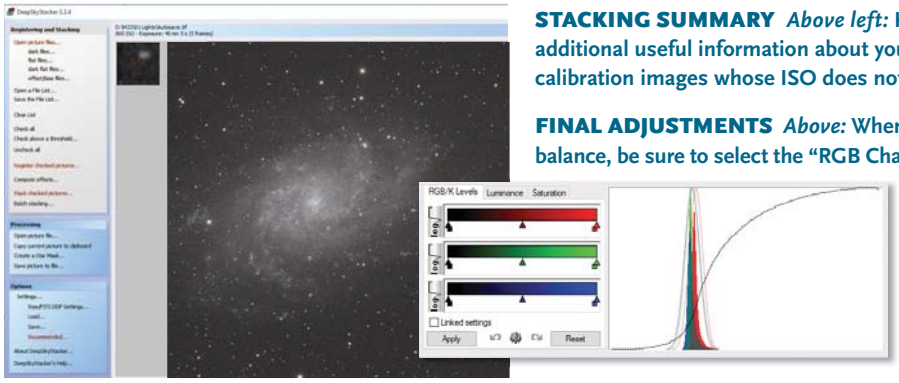
specified, click OK. The program then automatically calibrates, aligns, and stacks your images. Depending on the speed and memory of your computer, and the number of frames you're working with, this process can sometimes take quite a while, so be patient.

Once the processing is finished, the program slowly displays the stacked image. It automatically applies default adjustments for brightness, contrast, and color (if you're combining color images). These adjustments are often not ideal and might yield less than optimum results. Fortunately, as with the display adjustments mentioned earlier, the automatic settings are only applied to the display image at this point.

You can try adjusting these settings here and applying them to the image, but *DeepSkyStacker* is geared toward stacking — leave the post-processing to other photo-editing software. To save your image without applying the automatic settings, click the Save command ❼. Then a "Save As" window appears, with which you can title the file and choose the file format you prefer in your favorite editing program. Make sure you select the "Embed adjustments in the saved image file but do not



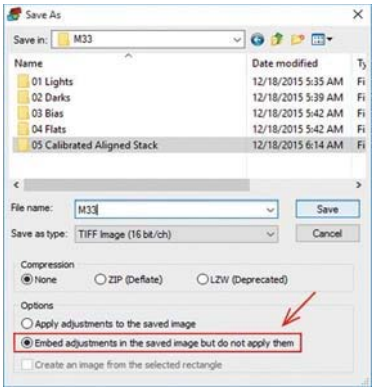




STACKING SUMMARY *Above left:* Here you can review the settings you've chosen and additional useful information about your images. Note the warning if you try to use flat frame calibration images whose ISO does not match that of the target frames.

FINAL ADJUSTMENTS *Above:* When combining JPEG images shot with an incorrect color balance, be sure to select the "RGB Channels Background Calibration" option in the Light tab of the Stacking Parameters window.

SMOOTH RESULT *Left:* When completed, the program displays the final stacked image with a series of default settings applied to the display image. Note that these adjustments are not applied to the data in the final saved file.



SAVING THE STACK Save your result as a 16-bit TIFF file with no compression, and be sure to select "Embed adjustments in the saved image but do not apply them" to get a raw linear file that can be adjusted in an another image-processing program such as *Adobe Photoshop*.

apply them" option. I prefer to save my photos as 16-bit TIFF Images with no compression. Use this option even if you've stacked JPEG images to avoid introducing compression artifacts in your final image.

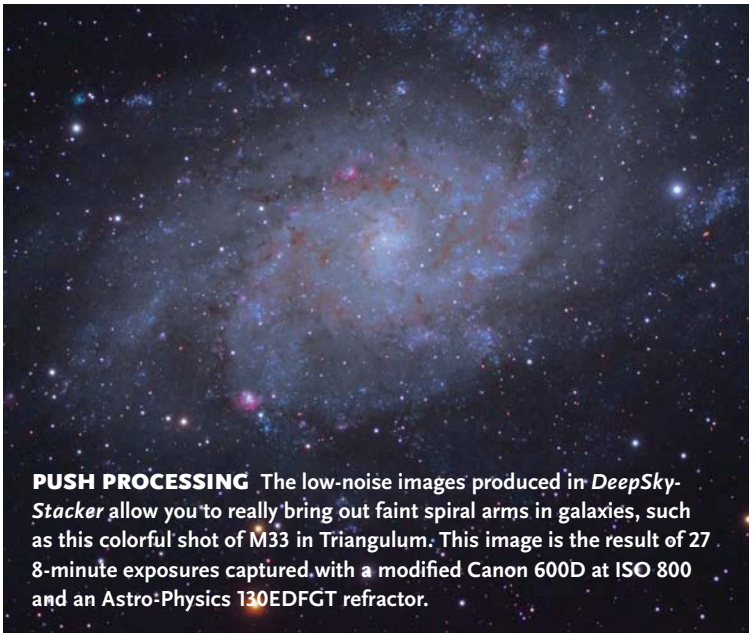
Now you can open the stacked image in your favorite image-processing program such as *Adobe Photoshop* and work on it. Note that the image will appear dark at first because it has yet to be stretched to reveal faint details.

Advanced Stacking Functions

DeepSkyStacker also has many advanced settings useful for more complex stacking routines.

The program can group and manage different sets of images or exposures simultaneously. For example, it can calibrate and combine photos of the same object shot on different nights, when you might have used different exposures and have different sets of darks and flats.

After an initial set of images is loaded into the main file group tab at the bottom, you can simply load additional files by clicking on the corresponding tab before you add those additional files.



PUSH PROCESSING The low-noise images produced in *DeepSkyStacker* allow you to really bring out faint spiral arms in galaxies, such as this colorful shot of M33 in Triangulum. This image is the result of 27 8-minute exposures captured with a modified Canon 600D at ISO 800 and an Astro-Physics 130EDFGT refractor.

Another advanced feature in *DeepSkyStacker* is its comet stacking tools (found at the right side of the screen). The program allows you to stack a series of comet photos either by isolating the comet and removing the trailed stars, or by aligning the stars and removing the comet. Access either method by clicking the Edit Comet Mode icon and selecting the comet's location in each of your images.

Now you'll need to click the Stack checked pictures command and select the Comet tab. Here you'll click the Stars + Comet Stacking option and then hit the OK button. In a few minutes, you should have a sharp comet image against a field of well-tracked stars. The success of this method will depend on how fast the comet is moving against the star background and the length of time between exposures. See the program's help file for additional information 8.

Troubleshooting

While I've had great success with *DeepSkyStacker,* occasionally it needs some adjustments to get the best results. For some newcomers, the program appears to function, but only part of an image is displayed when it completes a stack. You might need to download the latest beta version of *DeepSkyStacker,* particularly if you're using a recently introduced camera. The beta version is actually the most recent, fully functioning program with the latest RAW decoding library.

If your final stack didn't properly register and stack your images, go back to the "Register checked pictures" command and then check the "Automatic detection of hot pixels" box in the Actions tab. Also, try reducing the "Star detection threshold" in the Advanced tab.

Stacked images can sometimes display dark and light streaks, often caused by dark frames recorded at different temperatures from your light frames. These artifacts can be reduced in the Stacking Parameters window. Here you'll select the Dark tab and check both the "Hot Pixels detection and removal" and "Dark Optimization" boxes. Additionally, you may need to experiment with the "Dark Multiplication Factor" settings.

Most often, your stacked result is not as colorful as you might prefer. Don't worry — it's normal for stacked linear images to appear dark, with low contrast and little color saturation. You'll adjust all of these issues in subsequent image processing.

Overall, *DeepSkyStacker* is easy to use with some practice, and it has the ability to streamline the tedious stacking process that is necessary with most deep-sky astrophotography. Stacking is the best way to greatly increase your image quality by improving the signal-to-noise ratio, which then allows you many more processing options. ✦

***Jerry Lodriguss's** new book* A Beginner's Guide to Astronomical Image Processing *will be out later this year.*