

Improve Your Astrophotography

Summary Notes – By Mary McIntyre

These notes will talk you through how to get started with image stacking and then onto basic Photoshop processing

Image stacking is the process used to layer multiple images of the same thing on top of each other using computer software. This increases the signal to noise ratio and will allow you to build up much longer total exposure time which will bring out much more detail than you'll get in one image.

Shooting the photos:

- Follow the notes from the beginner's guide to astrophotography to select the correct ISO and exposure times
- Always shoot in RAW when stacking to ensure no compression of data
- You will be taking multiple images of the same thing so make sure your camera is set to continuous and use a remote shutter cable or intervalometer. If you shoot a set of images for stacking, you may hear them referred to as lights, light frames, subs or sub-exposures
- Make sure your camera or telescope tripod is firmly anchored and can't be easily knocked or moved. If you have pets, keep them indoors so they don't nudge the tripod
- A mount that is tracking will produce much better results
- You may be imaging the same target on multiple nights, so align the object on your camera sensor in a way that is easy to replicate so that you don't get stacking artefacts. If imaging through a telescope you do this by rotating the camera in the telescope eyepiece holder
- If producing a telescopic mosaic of a large object, make sure you align the camera so that any adjustments made in the RA and Dec motors equates to horizontal and vertical movements across the object. This will make it easier to map out the mosaic. Make sure you have plenty of overlap on each section

Calibration Frames:

- Calibration frames will produce a much better result as they remove noise and optical imperfections in the imaging train, particularly with deep sky object imaging
- **Dark Frames** - remove dark signal noise from the camera. They will also remove dead pixels and amp glow. This kind of noise differs with temperature and age of camera
- You need approximately half the number of darks as you have lights (your images), so shoot the necessary number of identical shots with the lens/telescope cap on & viewfinder covered. Temperature must be the same so it's best to shoot darks at the beginning or end of your imaging run
- **Flat Frames** - remove optical aberrations & uneven lighting from the imaging train, such as vignetting, dust & scratches
- Take a series of images of an evenly illuminated white surface, with the camera in exactly the same position. This could be your telescope pointing at a laptop screen with a blank Word document open, or a tablet with an illuminated white screen, or a light box
- Start with ISO-400 or lower for approx. 0.2 to 2.5 seconds. Take a photo then review the histogram; aim for the peak on the histogram to be around 50% brightness, so adjust the shutter speed until you get to around 50%. Then take about 30 shots
- **Bias Frames** - remove read-out signal from the chip created by the electronics of the camera

- Keep ISO the same as your lights but select the fastest shutter speed. Take about 30 shots with lens/telescope cap on & viewfinder covered
- Temperature is not important for bias frames so you can reuse them for future imaging runs

Image Stacking:

- Lunar, solar and planetary imaging can be stacked using Autostakkert! 2 or Registax 6 which are both free to download. Registax 6 also has an excellent wavelet sharpening function which is very useful.
- Deep sky objects can be stacked using Deep Sky Stacker which is also free
- If producing star trails images, then use StarStaX or Star Trails
- Check regularly for software updates
- It is better to stack fewer high quality images. If you put junk data in, you will get junk data out!

Autostakkert! 2 Basics:

- AS!2 can stack video or still frames but still frames will need to be converted into TIFFs before stacking

Stacking Solar/Lunar Images:

- Open AS!2. Drag and drop the file(s) you want to stack into the programme
- Make sure you select "surface" at the top left
- Click on the preview window. Find a good, high contrast area for the software to analyse the quality of each frame. Press control and click the mouse pointer over the area. Change the size of the analysis frame by pressing control and + or -. A larger frame will take longer to analyse. Click back to the control boxes window and click on "analyse". The software will then look at every image in the set and order them by quality
- Once the analysis is complete, you will see a line graph appear which represents the overall quality of all of the frames. As it is better to only stack the best frames, look for the point where the line crosses the 50% line and press control and click that point. In the box on the top right, you will see the percentage of frames that will be stacked
- You now need to place your alignment points. Click back to the preview window, which will now be showing the frame that AS!2 thinks is the best quality image of your data set. On the left, click "place AP grid" and the entire disc of the Sun/Moon will be covered in boxes. Now go back to the control box window and click "stack". Once complete, the software will automatically save 2 versions of the stacked image in a folder one level above the data set. One is the convolved version which has been automatically sharpened. Chose which version is best and edit it in your favourite image processing software

Stacking Planetary Images:

- Open the image files as above, but once opened make sure you select "planet" instead of "surface"
- Repeat the analysis step as above
- Instead of using a grid for your alignment points, you need to add them manually. Look for some high contrast areas, for example if you are stacking Jupiter, place alignment points along the borders of the cloud belts. If stacking Saturn, place them around the rings. Adjust the size of the alignment point boxes if necessary; you want to ensure you can get about 8 or 10 across the disc

- Stack the best images as above

Registax 6 for RGB Realignment & Wavelet Sharpening:

- Open Registax 6 then drag and drop the stacked image into it
- If you have a blue or red fringe anywhere on your stacked image it is because the stacking software has aligned the 3 colour channels incorrectly during the stacking process. Select “RGB Align” from the function panel on the right hand side, then use the arrow keys to nudge the colour layers back into alignment
- If you want to sharpen the wavelets, select the “wavelet” tab on the top left and a panel of 6 sliders will appear. Starting at the bottom, drag the sliders across to sharpen each layer. The exact amount of sharpening needed will vary from image to image. Be careful not to over sharpen as it will introduce artefacts. Experiment with the de-noise buttons for each layer if needed. Once you’re happy with the result, click “do all” at the top of the window then save the image

Deep Sky Stacker Basics:

Deep Sky Stacker is much more complicated to use, but often the default settings will work well so don’t panic! Below are the very basics to get you started, but once you become familiar with the different menus, just experiment and see what effect they have on your image (this is what cloudy nights are for!)

- Firstly, look through your images and delete any which have star trailing or any obvious problems in them. It will not do you any favours to include them in the stack
- Open DSS. On the top right, click “*open picture files*” and select your light frames. Next click “*open dark files*” and select your darks. Next click “*open flat files*” and select your flats. Then click “*open offset/bias files*” if you have shot some bias frames.
- At this point you can click “*save file list*” and DSS will retain the list so it makes it quicker to add more images to the list at a later date
- Click “check all” to select all of your files. Next click on “register checked files”. In the actions tab, make sure the top 2 tick boxes are selected, but uncheck the “stack after registering” box.
- Click to the advanced tab. Now you need to change the star detection threshold. Click the “compute number of detected stars” button and wait for the analysis to be done. You want to aim for around 100 stars, otherwise if you are stacking images in an area of dense starfield, the stacking process will take forever! Adjust the slider and repeat the analysis until you have the right number. Note: The slider works the opposite way to what you’d expect; a lower percentage will detect more stars.
- Click back to the actions tab and click “ok”. DSS will analyse all of your light frames and give them a score. When it has finished, double click on the “score” button and it will reorder them, lowest score first. Look down the list and un-check the light frames with obviously lower scores than the others. Remember you are better off to stack fewer, high quality images. Once you’ve removed the bad frames, chose “*stack checked pictures*” from the list on the left. DSS will now stack your images.
- Once stacked, the software will automatically save the stacked image in the same folder as your light frames, with the name “*autosave.tif*” or if you have saved the file list it will give it the same name as your list.

Basic Photoshop Processing:

A stacked deep sky image at a glance may not look much different from one of your sub-exposures. However, there is a lot of data hidden within those images which can be brought out using some basic processing using Photoshop. The first step in this is stretching the histogram using levels and curves adjustments. These functions give you the ability to adjust specific parts of the image without affecting the rest of it. You don't need an expensive top of the range version of Photoshop to do this; all my processing is done with Photoshop CS2, which is available to download for free.

- Open Photoshop, then drag and drop your image into it. If you are using an old version of Photoshop, you may need to change the image into an 8-bit image first. To do this, select *image > mode > 8bits/channel*
- Before making any changes to the image, first create a duplicate layer. Then if you ruin your image, you can delete that layer and it will preserve all of your previous steps. This is a good habit to get into because when you begin to get more involved in advanced processing, you may spend many hours working on the same image. To create a new layer, click *Layer > Duplicate Layer*. You can then name each layer to what you like to help you keep track of where you're up to.

Levels and Curve Adjustments:

The ability to preferentially adjust different parts of the image is an extremely powerful tool. However, it is better to make really small adjustments to the image each time and then repeat the process over and over again until you get the result you want. Moving the sliders too far each time will not produce a good final result. I generally start with levels and then move on to curves, and alternate between the two as many as 15 times.

- To work on levels, click *image > adjustments > levels* (or click control L as a shortcut). A graph will appear with a peak, and the peak is where all of your data is. Make sure you have selected channel RGB (you can experiment adjusting the individual colour channels separately once you are more confident with Photoshop). There are 3 points along the x axis which you can move. Make sure you don't move the left and right sliders so far that you cut off part of the peak, otherwise you will lose detail from the image. The middle slider will adjust the black point in the image. Begin by making small adjustments and keep an eye on the effect it is having on the image. When you've finished, click "ok"
- To work on curves, click *image > adjustments > curves* (or click control M as a shortcut). Once again working on channel RGB, you will see a straight line graph. This line represents the gradient from dark to light within your image. Make sure you have selected the eye-dropper tool from the left side panel, and then whenever you click an area of the image, it will show you on the line graph where on the graph that region falls. This will help you to stretch the areas of the image that you want to enhance. However, you first need to put anchor points on the parts you don't want to be affected by adjusting the graph. First of all, point to the darkest part of your image then click the line graph where that area falls. This point will now stay put when you adjust other parts of the line. Do the same for the brighter parts of your image so that they don't get blown. Now you can make small adjustments to the other parts of the graph without affecting the darkest and lightest parts. Once again, make the adjustments very small; it's better to do small adjustments 10 times than to do a big stretch in one go. Each time you finish the adjustments the line graph will reset to a linear plot

- Once you've finished a few iterations of curves adjustment, go back to levels again and reset the black point, and make other minor tweaks. Repeat this process over and over until you are happy with the result

RC Astrotools:

If you buy the RC Astrotools plug in for Photoshop, there are a series of pre-produced actions which are fantastic for astronomy image processing. Every image will respond differently so there are no hard and fast rules here. Just create a new layer each time you try a new action, then check the levels and curves again after each one. If you don't like the effect the action has had, just delete the layer and start again. There are lots of tutorials on You Tube which will help you to get to grips with this tool kit.

When you have finished stretching, you can then make small adjustments to the colour balance, saturation, etc., using the functions in the *image > adjustments* menu. Just keep adding duplicate layers before changing anything, just in case!

Once you are happy with the image, you need to merge the layers together. To do this, right click the mouse over the layers box on the bottom right, and select "flatten image". Now you can save it in TIFF or JPEG format.

Using a Layer Mask:

Many astronomy objects have a huge dynamic range, which means that some areas are much brighter than others. A good example is M42 the Orion Nebula. In order to get all the faint gas clouds around the outer edge, the trapezium area in the core will almost always become completely over-exposed. There is an easy way to deal with this. When you do your imaging run, do a separate set of exposures which have a shorter exposure time to suit the brighter areas. Stack them as you would the other data set, then process it in the same way. You need to make sure that when you stretch the histogram that the brightness and colour levels in both images are quite closely matched. Then you can use a layer mask process to blend the two images together. This process can be used to blend together any two images, for example planetary and lunar conjunctions where the Moon has had to be over exposed in order to detect the planet, or if you are imaging the Sun in H-alpha, you often need different exposure levels for prominences around the limb compared to the disc.

- Open Photoshop then drag and drop both images into it. Click on the image which has the core over-exposed. Press *control A* to select all, *control C* to copy, then click on the core image and click *control V* to paste. The first image is now on top of the second image. In the layers box on the bottom right, click on the icon which looks like a rectangle with a circle in inside it. This creates a layer mask. You need to check that the images are properly aligned with each other, so in the layers box, select "*difference*". Select the move tool from the left panel, and drag the top image so that it is properly aligned. Once you've done this, change the layers box back to "*normal*". Now select the brush tool, at the top make sure the size is suitable and set the mode to "*exclusion*". Using the mouse, paint out the area that is over-exposed and the underneath image will show through. Don't panic, it will look a bit odd at this point! Once you've finished, from the menus at the top, click *filter > blur > Gaussian blur*. Photoshop will now attempt to blend the edges of the painted out area. In general it does a good job, but if you need to make any corrections use the slider which appears in the box until you're happy. Then go back to the layers box and right click to flatten the image. You can now tweak the image or just save it.

Other Image Processing Software:

- Fast Stone Image Viewer is a free download and is a fantastic piece of software. It gives you the ability to make all the usual adjustments you would expect from an image processing software, but also has levels and curves adjustments. It also allows you to easily label and annotate your image. It allows batch renaming and batch conversion from one file format to another which is very useful for stacking with Autostakkert! 2 and Registax 6
- Lightroom is excellent for batch processing, archiving and has many different functions for image processing. It can export into a variety of file formats and will resize if necessary
- Focus Magic is an excellent software for sharpening images. It is less likely to produce artefacts in the image than the sharpening method used in other software packages
- Star Spikes Pro will allow you to enhance star spikes present in images taken with telescopes that use mirrors. Refractors do not produce spikes but if you really like them you can add them to refractor images. Some people hate them, some people love them, but if you love them, this software will plug in to Photoshop or Paint Shop Pro and allow you to get artistic!
- Pixinsight is an extremely powerful astronomy processing software. It works in a very different way to any other software and as such has a steep learning curve. But it produces some very striking results if you can spend some time getting to know it

Software Downloads:

Autostakkert! 2 - <http://www.autostakkert.com/wp/download/>

Registax 6 - <http://www.astronomie.be/registax/download.html>

Deep Sky Stacker - <http://deepskystacker.free.fr/english/index.html>

Star Spikes Pro - <http://www.prodigitalsoftware.com/StarSpikesPro4.html>

Focus Magic - <http://www.focusmagic.com/>

StarStaX - <http://www.markus-enzweiler.de/software/software.html>

Star Trails - <http://www.startrails.de/html/software.html>

Further Reading:

<http://www.budgetastro.net/calibration-frames.html>

Shooting Stars: The Ultimate Guide To Photographing The Universe by Nik Szymanek

<https://astronomynow.com/shop/product/shooting-stars/?v=79cba1185463>

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