Processing DSO LRGB light images with bias, flats and darks to a single LRGB image

Using Atik Dawn, FitsLiberator and Photoshop to process and combine sets of LRGB (Luminance, Red, Green, Blue) light DSO (Deep Sky Object) images with bias, flats and dark compensation images into one LRGB image.

Keith Ehren

www.astroworkbench.co.uk

Contents

Table of figures

1 Introduction

In the realm of astrophotography it's a fairly safe bet to state that there are more LRGB image processing tools than you can shake a stick at, and everybody has their own favourite processing procedures that they follow.

I make no bold claims for the procedure that I detail in this document except to say that over the years I have tried a lot of software packages and procedures and this document is a distillation of those and the procedure that I have settled on when processing my LRGB images.

These procedures are for processing LRGB DSO (Deep Sky Objects) and cannot of course be made to be 100% generic for all types of DSO and exposure circumstances, they do however provide a solid platform upon which you can launch into the realm of LRGB processing.

The software tools that I use are as follows:

- Atik's Dawn on the captured FITS files (I capture my images via an Atik CCD and have found their capture and processing software to be simple to use, effective and bug free);
- FitsLiberator to produce 16-bit TIFF files from the FITS files;
- Photoshop for the main processing on the TIFF files including the use of the following Photoshop plugins:
  - gradiantXterminaor (https://www.rc-astro.com/resources/GradientXTerminator);
  - WhiteCal (https://www.deepskycolors.com);
  - Hasta La Vista Green HLVG (https://www.deepskycolors.com);
  - Astronomy Tools (https://www.prodigitalsoftware.com/AstronomyToolsActions.html).

The basic outline of my image processing procedure is:

- Use Atik's Dawn software to produce master bias, dark and flat FITS files;
- Use Atik's Dawn software to apply the master flats and dark to the light (L, R, G and B) images, align and stack into individual L, R, G and B FITS files;
- Use FitsLiberator on the stacked L, R, G and B FITS files to apply some pre-processing and save them as TIFF files;
- Use photoshop on the L, R, G and B TIFF files to process the images and combine them into a single LRGB image. Save as TIFF and JPEG.

This article and others can be found on my website www.astroworkbench.co.uk.

2 Produce master Bias, Darks and Flats

Set my separate document *LRGB imaging setup and acquisition* for how to capture sets of bias, darks, flats and lights. The notes below detail how to process these images once acquired.

I use Atik's Dawn software, which is the software shown in the screen shots below, but the processing principles are the same if using different processing software.

2.1 Bias

A master bias only has to be produced once.

Combine all bias frames into a single master bias. Ensure that all alignment options are switched off in your software (i.e. only stack, **do not align**). This master bias will only be used in the flat frames.

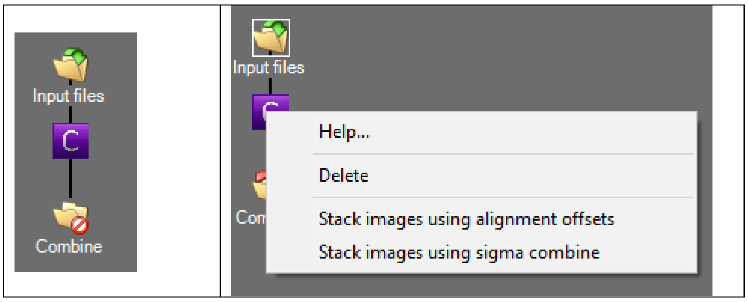

Figure 1 - Produce Master Bias (Atik Dawn)

2.2 Darks

A master dark for each combination of exposure time and CCD temperature must be produced, but only needs to be done once.

Combine all dark frames into a single master dark. Ensure that all alignment options are switched off in your software (i.e. only combine/stack, **do not align**).

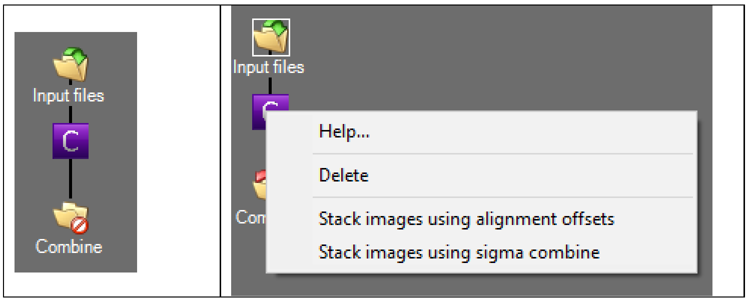

Figure 2 - Produce Master Dark (Atik Dawn)

You do not have to apply any bias frames as bias is already intrinsically present in the dark frames by the action of capturing the darks.

2.3 Flats

A set of flats is required for each filter and CCD temperature combination for each observing run unless your imaging equipment orientation is never changed, but even then additional dust may be introduced between observing runs requiring new flats.

1) The bias master must be subtracted from every flat frame. Hence the flat frames must be processed as light frames with the master bias subtracted from each.
2) Combine the bias corrected flat frames into a single master flat for each of the four filters (LRGB). Ensure that all alignment options are switched off in your software (i.e. only stack, **do not align**).
3) You will now have four master flat frames (e.g. *master flat L.fit*, *master flat R.fit*, *master flat G.fit*, *flat* and *master flat B.fit*).

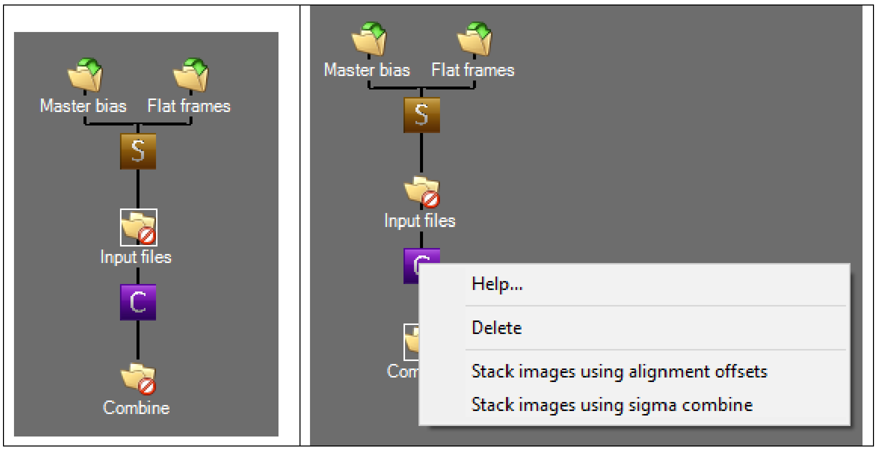

Figure 3 - Produce Master Flats (Atik Dawn)

3 Process LRGB Lights

3.1 Using Atik's Dawn software to apply master dark and flats images to LRGB lights

- Load the *Monochrome 3* template (shown below);
- For each set of L, R, G and B light images we must:
    - Apply master dark to each light frame;
    - Apply the correct master flat for the appropriate filter to each filtered light frame set (divide);
    - Do not apply any bias master as this was incorporated previously to the master flat;
    - Align and combine/stack.

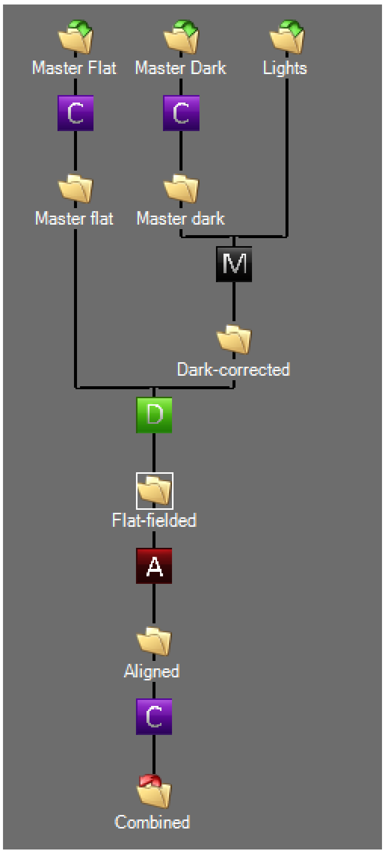

Figure 4 - Apply Master frame Corrections (Atik Dawn)

After performing the above sequence flow for each set of the L, R, G and B Light image sets (the master dark will be the same for each, but the master flat will be different for each) you will have four files: A dark corrected, flat corrected, stacked and aligned image for L, R, G and B (e.g. M81-L-combined.fit, M81-R-combined.fit, M81-G-combined.fit, M81-B-combined.fit).

3.2 Process in Fits Liberator to get TIFF files

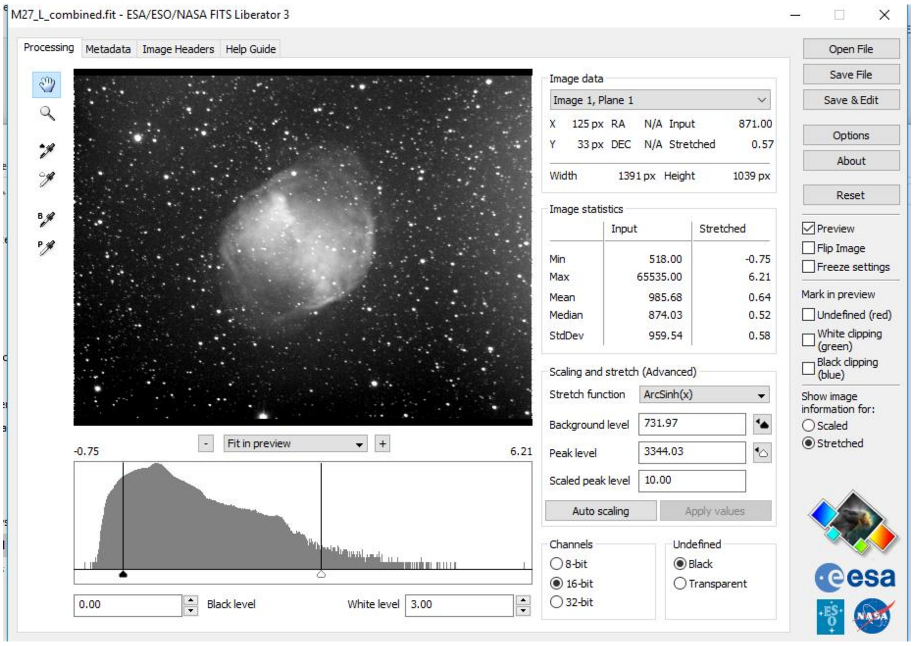

Figure 5 - FitsLiberator

1. Use Fits Liberator on each of the L, R, G and B combined files from the step above (e.g. M81-L-combined.fit, M81-R-combined.fit, M81-G-combined.fit, M81-B-combined.fit) to process them and save as a TIFF:

- Open each file in FitsLiberator;
- Ensure the *Channels* radio button it is set to 16 bit;
- Set the histogram white and black level sliders;
- Click on the Auto scaling button;
- Use arcSinh(x) as a first attempt but experiment with the others;
- If the image is too dark, increase the Scaled Peak Level to higher values (e.g. 100, 1000).
- Use the *Save File* to save the image as a TIFF.

2. You now have 4 TIFF files (e.g. M81-L-combined.tif, M81-R-combined.tif, M81-G-combined.tif, M81-B-combined.tif).

3.3 Process TIFF files in Photoshop

These instructions include the use of four photoshop plugins that I have found to be of significant help:

- gradiantXterminaor (https://www.rc-astro.com/resources/GradientXTerminator);
- WhiteCal (https://www.deepskycolors.com);
- Hasta La Vista Green HLVG (https://www.deepskycolors.com);
- Astronomy Tools (https://www.prodigitalsoftware.com/AstronomyToolsActions.html).

1. Open all 4 TIFF images (L,R,G,B) in Photoshop.

2. For each of the L, R, G, B images select *Image->mode* and:
   - Change to 16-bit which will auto display the HDR toning screen. If already 16-bit then open image->adjustments->HDR Toning;
   - Try the two settings: *Local Adaptation* and *Exposure and Gamma*, depending upon the object and exposure decide which one reveals the best detail (do not worry about any gradient and other image issues at this point as they will be removed later);

3. For the L image use *gradiantXterminaor* to remove any gradients as follows:
   - With our luminance channel open, select the *Lasso Tool* from the toolbar and draw around the DSO, being careful not to clip the DSO;
   - Inverse the selection, *Select > Inverse*;
   - Open GradientXTerminator. Set the *Detail* to Medium and *Aggressiveness* to Low or Medium. Click OK;

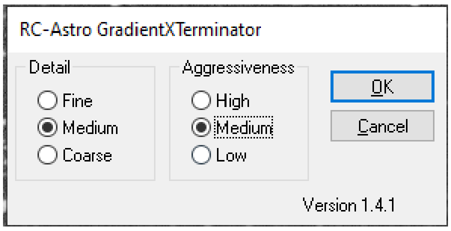

Figure 6 - GradiantXterminator

   - This has applied a mild gradient reduction to the image. Now we can home in and apply a more aggressive gradient removal;
   - Select the Magic Wand Tool from the toolbar and set a *tolerance* of around 8. Then click on the background of the image to select it. You may need to increase the tolerance if no selection is made.
   - Now re-select the Lasso Tool and whilst holding the alt key, draw once again around the DSO, to remove it from the selection:
   - Now re-open GradientXTerminator and apply another gradient removal with *Detail* set to Fine and *Aggressiveness* set to High. All gradients should now have been removed from the image. It may now be necessary to adjust the brightness of the image using the Levels tool.

4. Repeat the above GradiantXterminaor process for your R, G and B images.

5. If any obvious gradient/light pollution remains on any of L, R, G, B:

    - Use the Astronomy Tools Plugin utility *Light Pollution Enhanced flatten* and on the first window popup increase the Dust and scratched radius, and on the 2nd window popup leave the threshold and drag down the curves.

    - If just the background around a DSO needs gradient/light pollution processing select the DSO with the *Lasso* tool and make it a separate layer via *Layer->New->Layer Via Cut*, then just apply the *Light Pollution Enhanced flatten* to the background layer, then alter levels on the new DSO layer to equalise and then merge both layers.

6. On Luminance image only select *Image->Adjustments->Curves*:

    - Enhance the faint data in **just** the DSO without blowing out the stars or the DSO core by making multiple anchor points on the curve by using ctrl-click on the black background, a star, the inner galaxy region and the arms. This will give you four anchor points on the curve. Now just adjust the anchor point for the galaxy arms of the galaxy to bring out the details.

    - Use *image->adjustments->levels* and adjust the first and middle sliders only to make the background dark and bring out detail of the object. Repeat curves and levels iterations (L image only) as required until you are pleased with the enhancements.

7. Repeat all of the above step on the R, G and B images.

8. Run the Astronomy tools *deep space noise reduction* on all L,R,G and B images.

9. Use the Astro tools plugin to run *Local Contrast enhancement* on the luminance image.

10. Luminance layer Unsharp Mask for DSO objects.
    - To just sharpen the Luminance layer of a DSO and not the stars (which can cause unsightly artefacts around the stars) duplicate the background layer (right click *Background* layer and select *Duplicate*). On the duplicate layer use the Astronomy tools *Select Brighter Stars*. This may also select parts of the DSO in which case use the Lasso tool to select the DSO while holding down the alt key and it will be excluded from the selection.

    - Now *Select > Modify > Expand* and try a starter value of about 5 pixels.
    - Now *Select > Modify > Feather* and try a starter value of about 5 pixels.

    - Now use Ctrl X to delete the stars from the duplicate layer.

- Now *Filter > Sharpen > Unsharp Mask* and try varies values until a pleasing enhancement of the DSO is obtained.
- Flatten the L image, you should now see that just the DSO has been enhanced and the stars have not been altered.

11. Luminance star size reduction
    - On the Luminance layer use the Astronomy Tools Action *Make Stars Smaller*. You can use multiple iterations but be careful not to over apply otherwise you will lose faint stars and processing artefacts will start to appear.

12. Combine R,G and B channels:

- Select the L image and select all, copy and create new image by ctl-A, ctl-C, ctl-N in the new image window that comes up set the Name to Object- RGB and the colour mode to RGB colour.

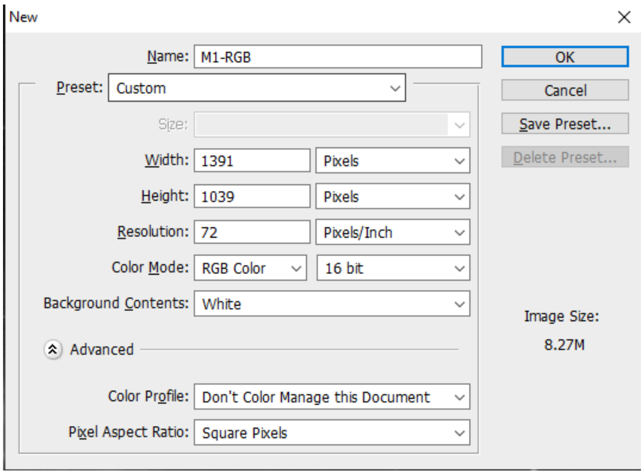

Figure 7 - A new empty RGB image (photoshop)

- On the new layer cloik on the channels tab and notice that it has RGB, Red, Green and Blue channels.

Figure 8 - RGB channels - empty (photoshop)

- Paste the R, G and B images into the R,G and B channels of the new image (ctl-A, ctl-C and ctl-v on the new documents selected channel) so that it now looks like the following. The RGB channel auto shows the combined R,G,B just pasted in.

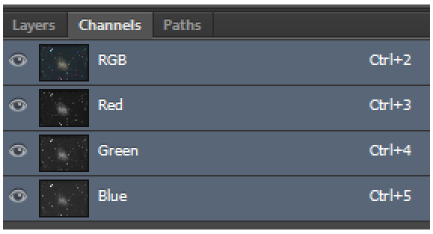

Figure 9 - RGB channels populated (photoshop)

- If the images in the separate R,G and B channels are out of alignment perform multiple iterations of making only two of the three channels visible so that you can see the stars in both visible channels superimposed on top of each other. Click the visibility on/off quickly on one of the two visible channels (i.e. a perform a blink comparison) so that any misalignment shows up. Select the move tool, and move the channel (via mouse or arrow keys) until it lines up with the other one on a very high zoom. Repeat for the third layer until all three are aligned..

13. Select the RGB channel, and If the colour balance looks a bit off, try the ***WhiteCal*** plugin to correct the RGB colour balance:
    - Select either a G2V star using the lasso or magic wand tool or just a part of your image that you assume should be white (e.g. a star or a galaxy centre).
    - Run the ***WhiteCal*** plugin and apply to the image. You may have to undo, reselect and run it a few times until a pleasing colour balance is obtained;

14. Use Hasta La Vista Green (HLVG) plugin to remove any green colour cast:
    - This works on the basis that a green colour only appears in some planetary nebula, unless you are certain that a green colour should be present in your image, run the HLVG plugin (the **Strong** option will remove **all** green, medium about half and weak just a slight amount) to remove unwanted green colour;

15. Add a Luminosity layer to your RGB image.

- On your RGB image, click on the Layers tab and then the Background layer, then go to the original L image and ctl-A, ctl-C and paste it on the new RGB image Background layer which will give a 2nd layer (called Layer 1);
- Change the layer's type to *Luminosity* and rename it to Luminance Layer;
- Change opacity until the sharp detail of the L layer shows through but doesn't swamp out the RGB information – usually around 50% is a good start.
- If the Luminosity layer is out of alignment select and move it on a high zoom until the stars overlap.

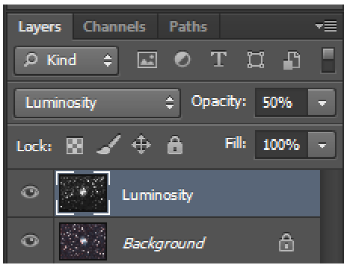

Figure 10 - New Luminosity Layer (photoshop)

- At this point you now have the Background layer as your RGB image and the you also have your luminance image as a separate layer.

16. Remove colour noise from RGB Background layer
    - If you have any residual colour blotches try the Astronomy Tools *Colour Blotch Reduction*

17. Further correct colour balance on RGB background layer. If the previous steps have not resulted in a visually pleasing there are some other methods that can also be tried at this point which may (or may not) help:

    - Adjust the levels of each individual colour channel, or
    - *Image > Adjustments > Colour Balance* and adjust the individual midtones channels until they all align on the histogram

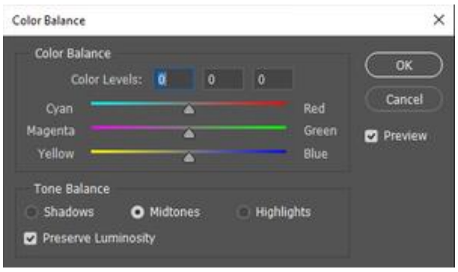

Figure 11 - Colour balance (photoshop)

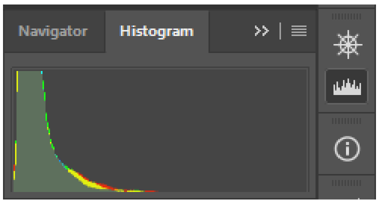

Figure 12 - RGB histograms

18. Increase RGB vibrance and saturation
    - Use the *Image > Adjustments > Vibrance* to increase the vibrance and saturation of the RGB image.

19. Apply Gaussian blur to RGB background layer
    - Because the RGB does not contribute much to the fine detail in the final image (this comes from the luminance layer), you can try a mild Gaussian blur to remove noise. Use *Filter > Blur > Gaussian Blur* and try a radius of 1-2 pixels to see if this enhances your image.

20. This is the final eyeball of your image, if not entirely happy then:
    - Run Another mild unsharp mask on the Luminosity layer only;
    - Make any finishing touches on curves, levels and colour balance.

21. Flatten image (i.e. flatten the L and RGB layers to one final image).

22. At this point save your image and you could try one final astronomy tools *Enhance DSO and reduce stars* but it may be too much so prepare to revert to the saved image.

23. That's it – crop as necessary and save your final image. You may also wish to also perform a *Save As* JPG at a suitable compression for easy sharing and publishing etc.

4 Example LRGB component and final images

This section shows examples of the different types of images discussed in this document. This example is the M27 Dumbbell Nebula which is a favourite DSO of mine and a great object to try out your processing on as it responds really well to LRGB imaging.

See my document *LRGB Imaging Setup and Acquisition* available on my website www.astroworkbench.co.uk for a full description of how to capture each type of image.

4.1 Master Bias

The figure below shows a master bias. These are used to compensate for any electronic noise present in any CCD (or CMOS) chip. They are dark (i.e. the cameras shutter is closed or scope is covered) and captured using the same temperature as your light images and the fastest speed, as close to 0 as possible, that the camera supports. You only need one master bias for each temperature that you use for light frame capture.

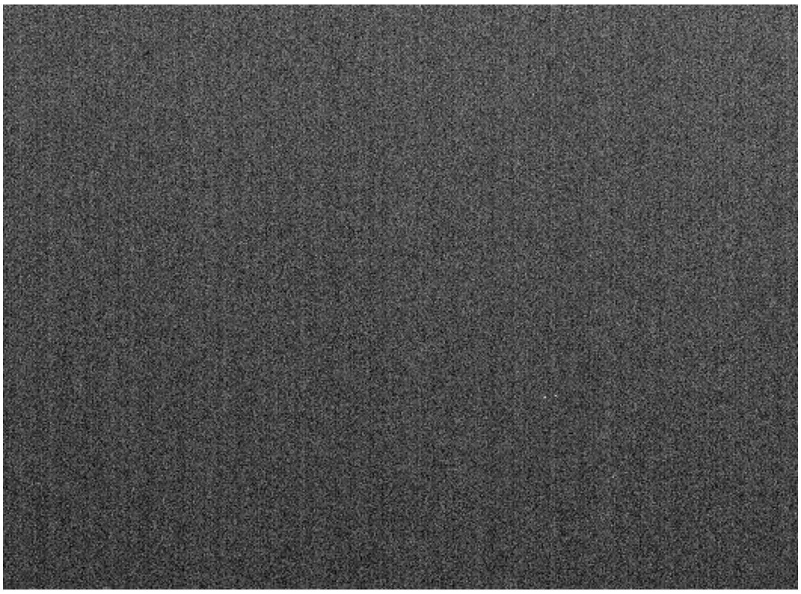

Figure 13 - Master Bias

4.2 Master Dark

The figure below shows a master dark, these images are used to compensate for hot pixels and are dark (i.e. the cameras shutter is closed or scope is covered) and captured using the same temperature and imaging time as your lights. Some CCD's have so few hot pixels (or amp glow) that you can get away without darks.

It looks very much like the master bias above except for the addition of the hot pixels.

You only need one master dark for each temperature and exposure time that you use for light frame capture.

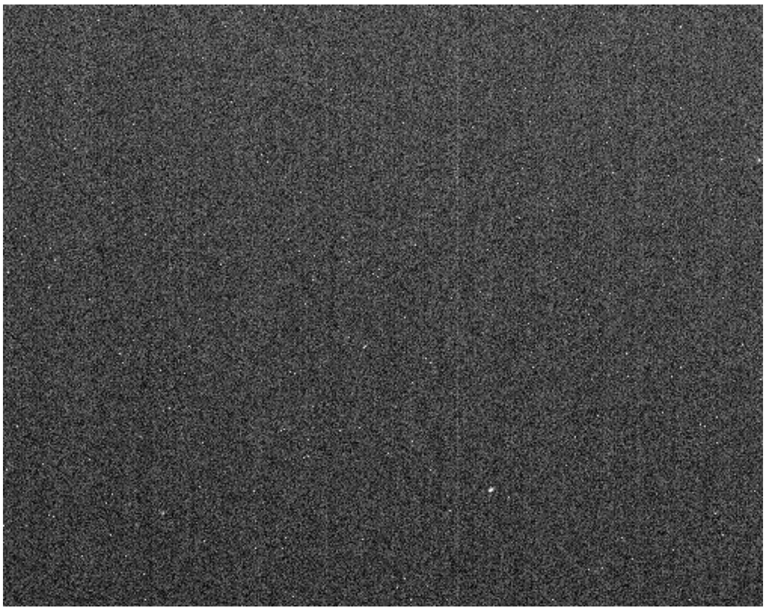

Figure 14 - Master Dark

4.3 Master Flat

The figure below shows a master flat for luminance images, it has been much enhanced for display purposes so as to clearly show typical image artifacts that flats are used to remove from the light images, in this case dust bunnies that appear as faint halos, corner vignetting from 1.25” filters that are right on the limit for the size of my Atik 383L+ CCD and the shadow caused by the pick off mirror in my Celestron OAG in a f6.3 image configuration.

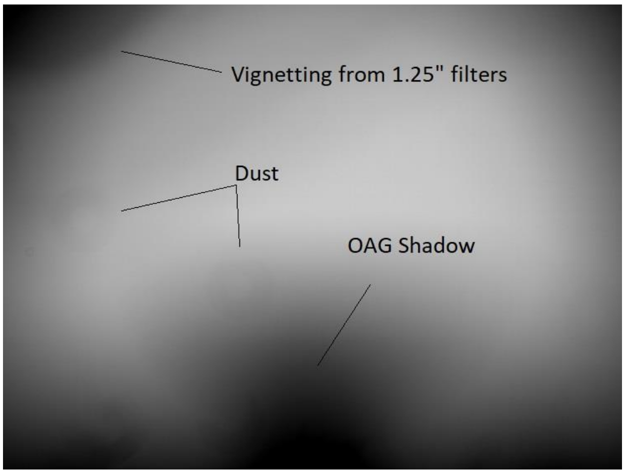

Figure 15 - Luminance Master Flat enhanced for display purposes

In the individual LRGB images shown below you can clearly see the vignetting and OAG shadows which are removed via this flat master frame during processing.

You will typically obtain a master flat for each filter used after every nights imagining session and is a little more involved that the capture of the other compensation masters above, see my document *LRGB Imaging Setup and Acquisition* available on my website www.astroworkbench.co.uk for a full description of how to capture flats.

4.4 A single L image

The image below is one luminance image, many would be taken and then have the master compensation frames applied to each and then aligned, stacked and processed as described in this document.

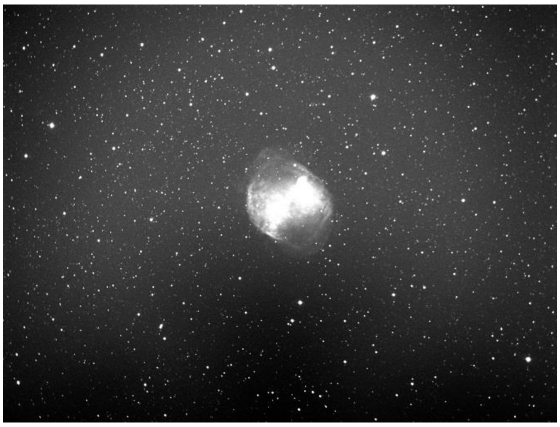

Figure 16 - A single raw L image

4.5 A single R image

The image below is one red image, many would be taken and then have the master compensation frames applied to each and then aligned, stacked and processed as described in this document.

Figure 17 - A single raw R image

4.6 A single G image

The image below is one green image, many would be taken and then have the master compensation frames applied to each and then aligned, stacked and processed as described in this document.

Figure 18 - A single raw G image

4.7 A single B image

The image below is one blue image, many would be taken and then have the master compensation frames applied to each and then aligned, stacked and processed as described in this document.

Figure 19 - A single raw B image

4.8 Final LRGB image

The image below shows the final result of utilising the image types described above and processed as described in this document.

Figure 20 - Final LRGB image