Processing RGB Astronomical Images with SAOImage DS9 and Adobe Lightroom

A guide by Jacob Brady

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Adobe Lightroom 5

Introduction

The production of an RGB Astronomical image is both an artistic and technical process. There are *standard ideals* for an image (good noise/detail ratio, no clipping, neutral/uniform sky…etc.), but after this it is up to the eye of the editor to create a "good" image. The aim of this guide it to familiarize the user with two pieces of software, SAOImage DS9 and Adobe Lightroom (version 5 was used for this guide), in order to build confidence in editing an image to meet the standard ideals, so that the user's artistic intuition can be revealed, rather than being trapped behind the basics of image editing.

A starting point: This guide assumes a starting point of *three .fits files*, each taken with a different filter, which will each correspond to either red, green, or blue. For visual spectrum "true color" images, filter choices should correspond to the respective wavelengths of light for red, green, and blue, though false-color images can be made by using different filters and using either red, green, or blue to "represent" that filter wavelength.

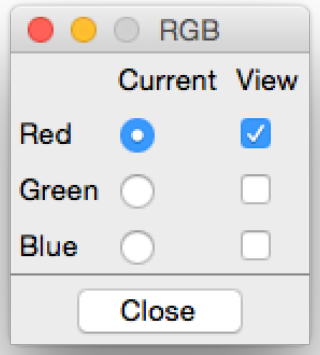
Starting Out in SAOImage DS9

Preliminary preparations:

- Open SAOImage DS9, go to "Frame" in the menu bar and select "New Frame RGB" from the dropdown menu.
- In the newly created "RGB" window, select each color channel (i.e. "Red," "Green," "Blue") individually and open the corresponding .fits file into it.
- In the "SAOImage DS9" window, select "zoom" and then "fit."

We'll be editing each color channel individually before looking at the combined color image. My typical workflow begins with editing the "Red" channel, but you can start with any of them.

Editing the first color channel:



- In the "RGB" window, ensure "Red" is selected in "Current," and only "Red" is checked in "View."
- In the "SAOImage DS9" window, select "scale" and then "log."
- Go to "Scale" in the menu bar and select "Scale Parameters…" A new window will appear.
- Drag the *high limit* bar (the green bar) on the pixel distribution histogram left until the image becomes almost entirely red. It should get pretty close to the red

Scaling Notes

Certain objects may look nicer and brighter using the sqrt scale as opposed to a log scale, though sqrt has a tendency to make stars entirely clipped, rather than the more gradient look in log scaling, so use it wisely (see Fig. 1 and 2).

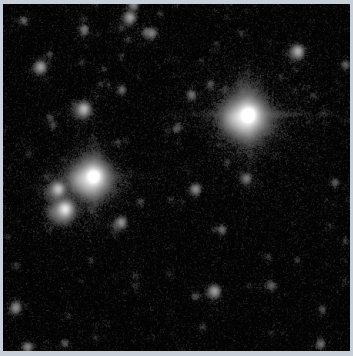


Fig. 1. Detail of stars with log scaling

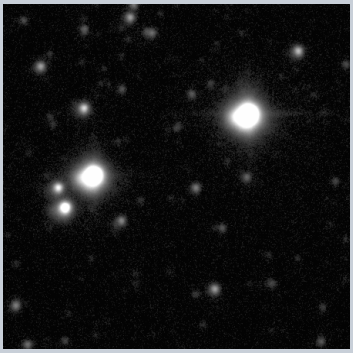


Fig. 2. Detail of stars with sqrt scaling

low limit bar—around 100-500 units away (for a log scale). The closer it is, the more "rough" the image will look, and the more sensitive it will be to small changes.

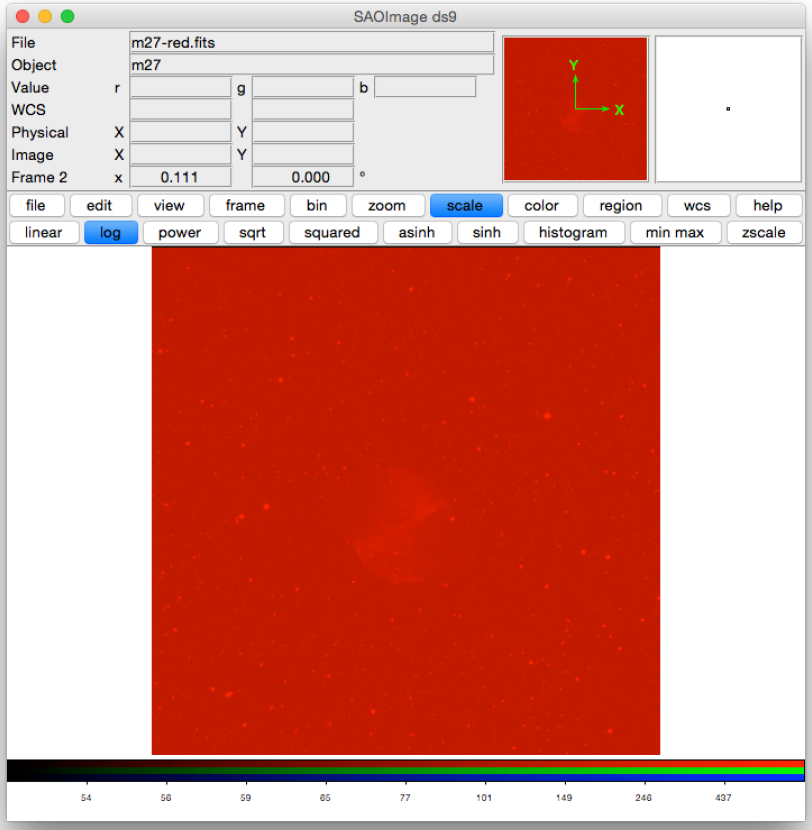


Fig. 3. Current working image after lowering the *high limit*

- Incrementally increase the low limit on the histogram (e.g. add 10 and apply… repeat). The background will start to separate from the object. Continue this process until the background is mostly black; at this point, work in smaller increments for more control. If the object starts to become 'carved away' by the black background, you've gone too far: lower the low limit. Air on the side of leaving more colored noise rather than cutting away at the object. This noise can be removed in Lightroom but detail can never be brought back.

Adjusting the *Low Limit*

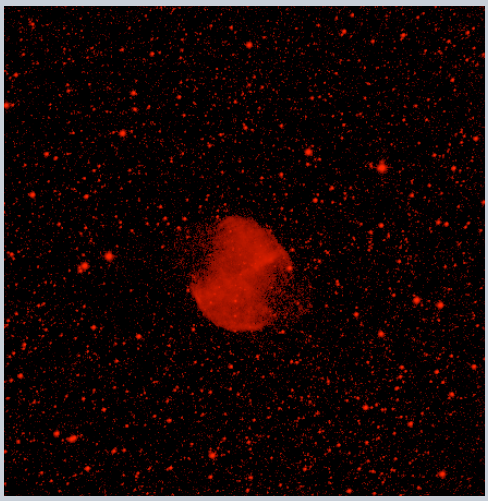


Fig. 4. M27 has become too 'carved away'

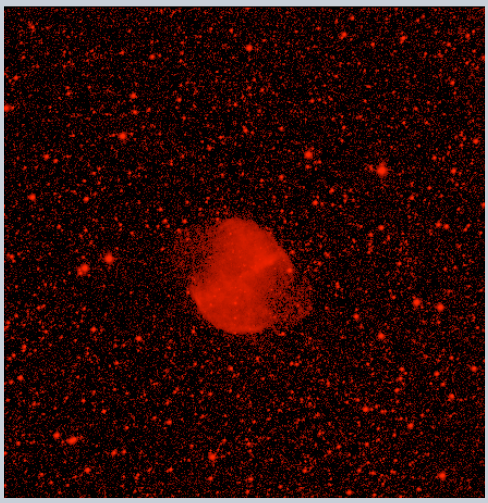


Fig. 5. Background has more color noise than ideal

- In our working image (**Fig. 6**), there is a good balance between noise and detail; let's call this good. Now, raise the *high limit* (green bar) on the "Scale Parameters" histogram back up until the most of the color noise is gone from the background, but the object doesn't become too dim. Do this incrementally again, probably beginning with around 500 unit increments (again assuming log scale—with sqrt scale, the increments will need to be much smaller). The key here is finding a balance between background darkness and object brightness. If need be, favor a slightly dimmer object rather than a brighter background.

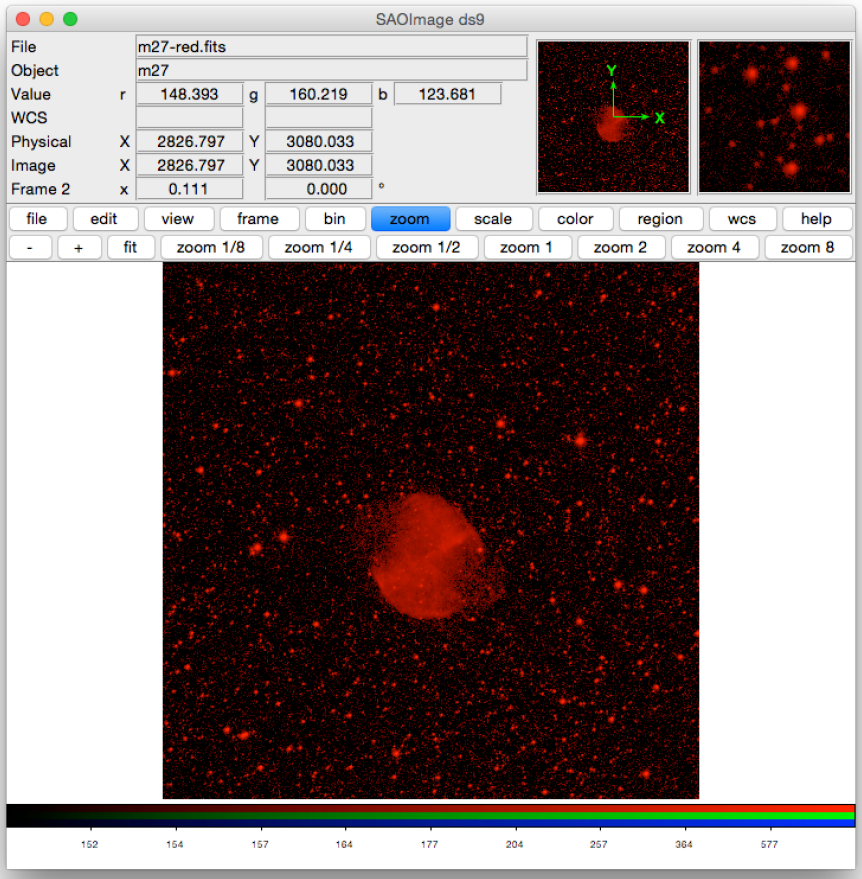


Fig. 6. Current working image, showcasing a fair balance between noise and detail after raising *low limit.* Here I aired on the side of a brighter object with more noise, and thus I'll probably end up making it more dim once all three channel are combined

- Once you have attained this balance (as in **Fig. 8**), zoom in on the object to be certain that none of the highlights are clipping. The red channel is complete.

Clipping Notes

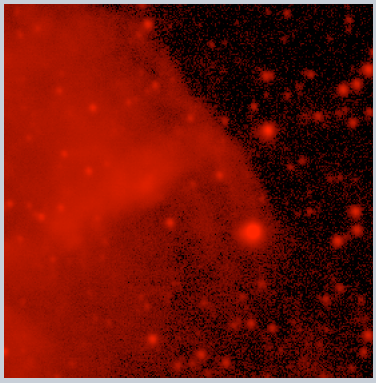


Fig. 7. Bright stars are clipped regions, so their brightness can be used as comparison to check for clipping. Since even the brightest part of the nebula structure is darker than the star, we are not losing detail from clipping.

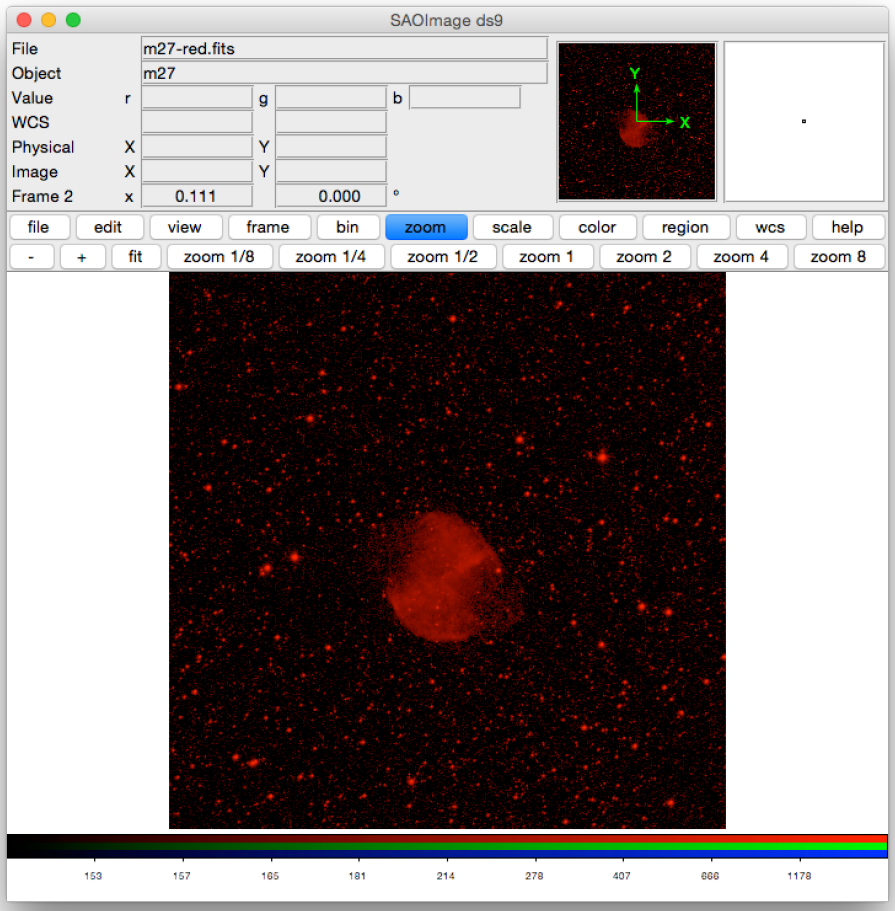


Fig. 8. Current working image after raising the *high limit*

Editing the other two color channels:

The process for editing the Green and Blue channels is identical, though the Blue channel can sometimes pose more of a challenge to perfect. If there was a prominent moon, or if the sky is light for some reason, it will be hard to get the background dark without the object becoming unfortunately dim. In this case, you may have to leave more blue background noise than would seem desirable, in order to get adequate definition in the object. A surprising amount of noise can be removed in Lightroom, but it's ideal to get as much right in DS9 as possible.

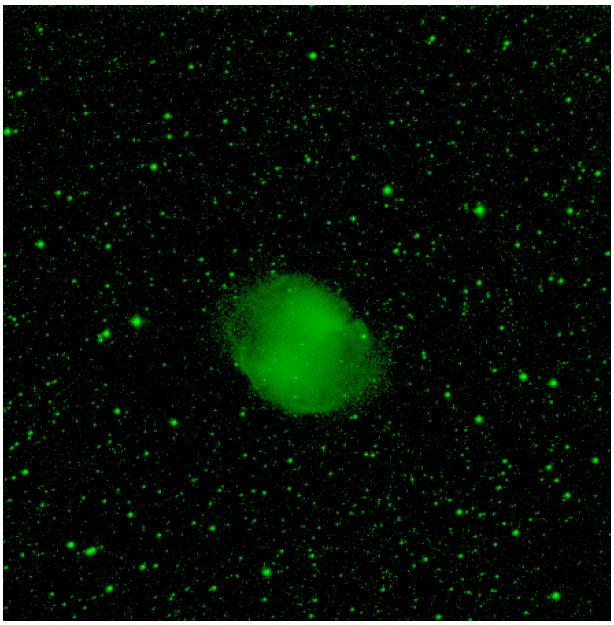


Fig. 9. Completed green image

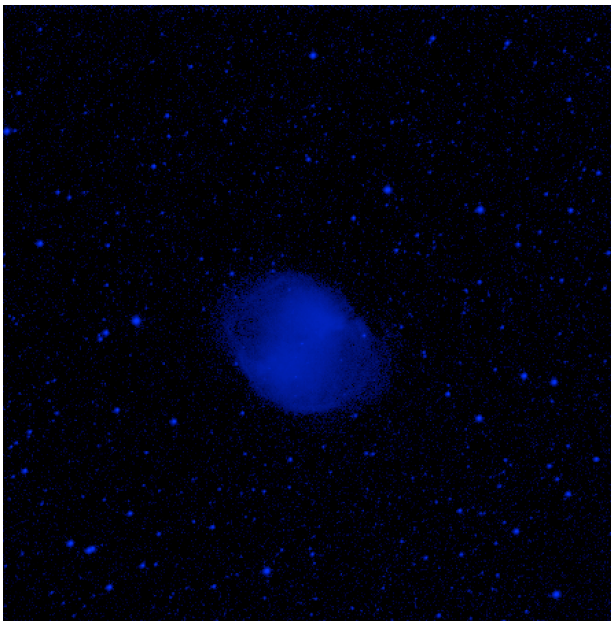


Fig. 10. Completed blue image

Combining the color channels:

- Check the view box in the "RGB" window for all three color channels.

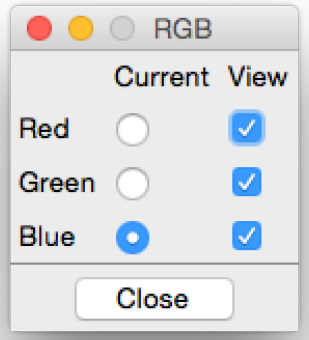


Fig. 11. Current working image—combined three color channels

- This combined image (**Fig. 11**) is overall a little bit too yellow/ orange, so the green and red channels need to be a little less prominent. I feel like the green might be the strongest, so let's start by changing that. While leaving the view on all three colors, select the green from the "RGB" window and

incrementally raise the *high limit* in the "Scale Parameters" window until the colors look more balanced.

Tip: Since astronomical objects themselves can be pretty crazy and diverse in color, use the background and stars as a guide for color balance.

- Changing the green didn't solve the red/orange-ness of the background, so let's switch to editing the red channel and raise its high limit to dim the red channel. Looking at stars zoomed in can help this process. Most stars should be white-ish, with some bluer and some redder. The dimmer stars may have a tendency to trend towards red, though this is alright as it can be fixed to a degree in Lightroom. Trying to make all faint stars not red will likely ruin the object color balance, so don't stress over these—just get them as neutral as you can.
- Another common technique I use for de-reddening background stars is to lower the blue channel *high limit* a bit. Do this as much as you can before getting too much blue background noise.
- When you think you're close, viewing professional images of the object can be beneficial to get a sense of color, though some is up to personal preference.
- Export as a TIFF with no compression and get ready to open up that bad boy in Lightroom.

Background Stars

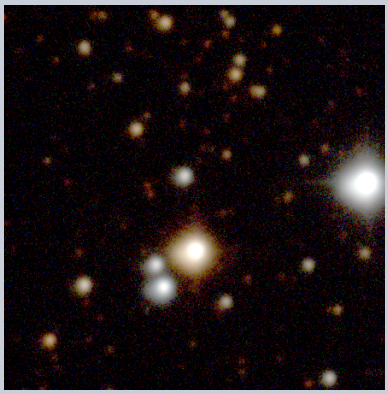


Fig. 12. Background stars are red and white. No blues—*suboptimal*

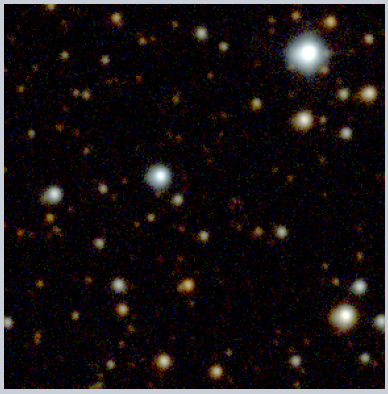


Fig. 13. Background stars are mostly white with some blue and red—*ideal*

Fig. 14. The completed RGB image in SAOImage DS9

Final Processing in Adobe Lightroom

Preliminary setup:

- Import the .tiff file into Lightroom.
- Open the "Develop" tab, locate "Noise Reduction," and increase the slider for "Color." Going from 0 to 1 will likely have the largest impact, and unless the object is really diffuse, you can just slide that bad boy all the way to 100. Most, if not all, of random colored background pixels will be gone. Watch to make sure the object itself doesn't lose a significant amount of blue from this, though. The image may look a little redder overall, though, and we can correct for this.
- Add some clarity (in the "Basic" area); this'll really make things crisp up. Unless the image looks really poor and I'm going to for just salvaging it, as a rule I never go above 40 in clarity. For a well exposed image I'll stay below 20. The lower the better; it'll keep the background smoother and we can add a little bit more to just the object with radial filter anyways.

Color Noise Application

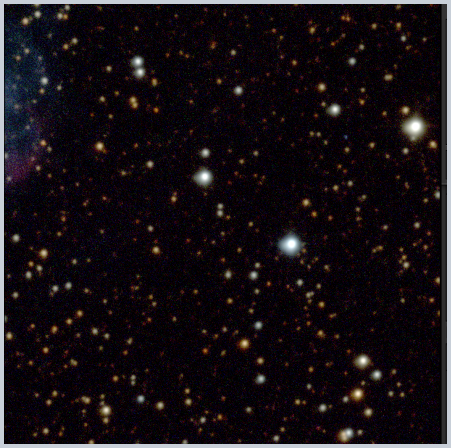


Fig. 15. Detail: Before color noise reduction

Fig. 16. Detail: After color noise reduction

Working with radial filters:

- If the object has a distinct structure that could be surrounded in an ellipse of some shape, such as M27, add a radial filter (Shift + M) around the object. Set the feather slider to at least 50, and check the box to invert the mask so that changes affect the object itself, not the surrounding stars and background.
- With the radial filter sliders, make small adjustments to temp and tint, on the scale of maybe 20 at the most, to get the object colored as desired[1]. We can add a little bit more clarity to if it *actually* makes it look nicer, not just overly-edited. Astronomical objects are pretty unreal as is, but overdoing the clarity or other adjustments can makes them look fake and too processed.

[1] For a more complicated technique, though one that yields much more precision, mess with the HSL sliders for the main image, rather than changing tint, temp or saturation sliders at all. This can help neutralize the background, and allows for more artistic control. This will be covered in depth the next edition of the guide.

- Let's play with the saturation slider for a little bit more control over colors. I wouldn't recommend going more than +5 or -5 unless you're trying to make things get crazy.
- Raise the exposure a bit to brighten it up.
- It's ok to play with shadows and highlights too for precision control, but often this doesn't have a huge impact and has potential to make it look overly-edited.

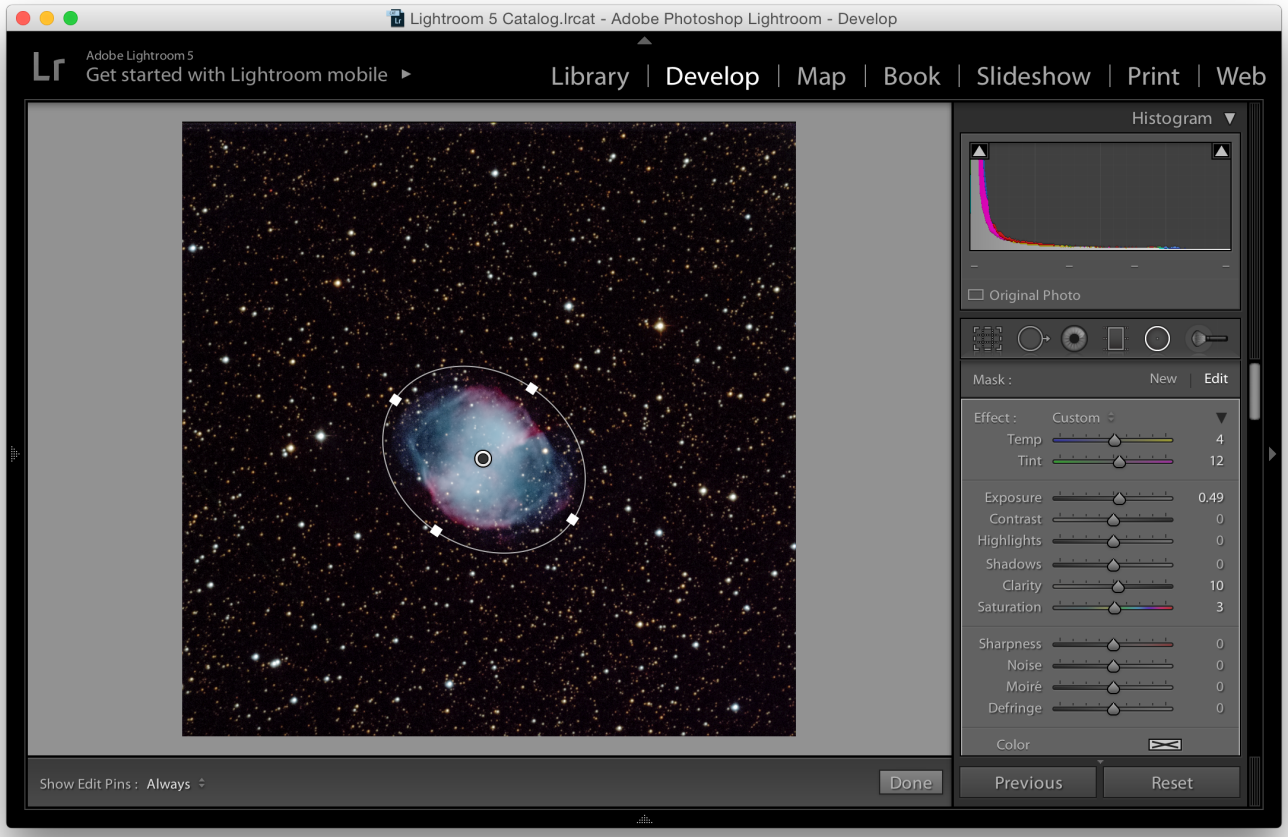


Fig. 17. Radial filter with changes applied

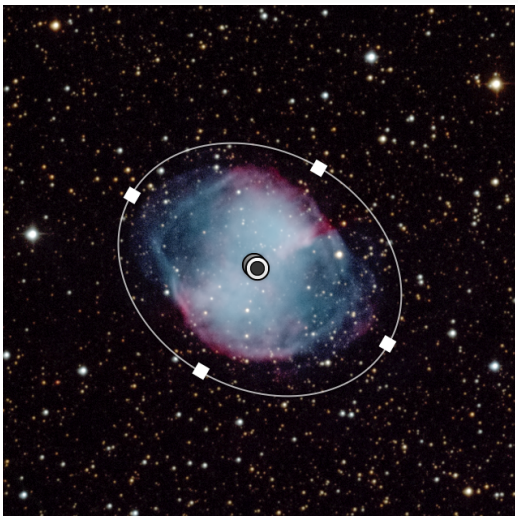


Fig. 18. The second radial filter is basically in the same place as the first

- Add a second radial filter in essentially the same location as the first, but *don't* invert this one. This one will let us edit only the background to get that it and the stars nice and neutral.
- In this filter, use the "Temp" slider to balance the background star color. Zooming in on the background next to the object can help, so that you can see both the background and object but in more detail. Often, this step will be 'de-reddening.' We want to get the stars blue, white, and red. Often this involves shifting the temp towards the blue.

- Dropping the saturation down can help get everything more neutral. For this example image, I ended up with -7 on temp and -15 on saturation. Having both red and blue stars is essential in a good image.

Back to editing the whole image:

- Scroll down to Noise Reduction again and hit up that "Luminance" slider to really smooth out the whole image. I recommend a value between 15 and 40, unless there is a ridiculous amount of noise, and then it's up to you. Zoom in for this step, and try to make the background noiseless, but only *just* that. With too high noise reduction, tiny stars are lost which ruins the depth of the image. It's better to have some noise and keep detail than lose detail for a smoother image.

Noise Reduction

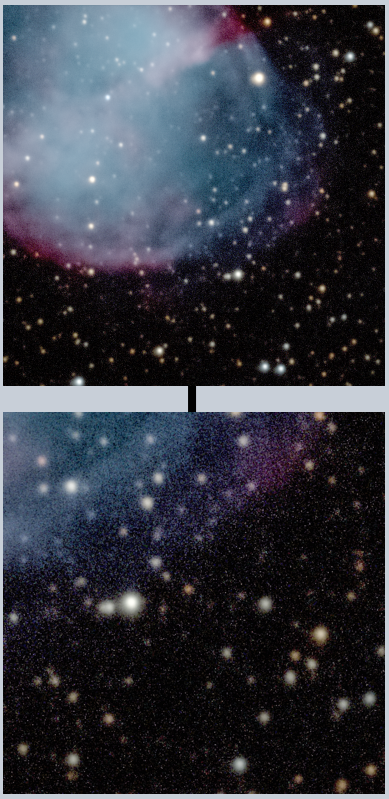


Fig. 19. The image without *noise reduction* applied. Slight crop (top) and super-crop (bottom)

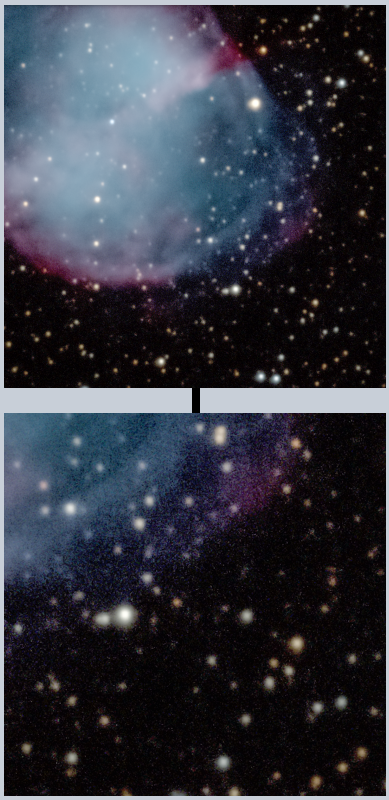


Fig. 20. The image with an ideal level of *noise reduction* applied. Especially in the super-crop (bottom) it is apparent that the black sky is much more uniform with minimal detail loss overall

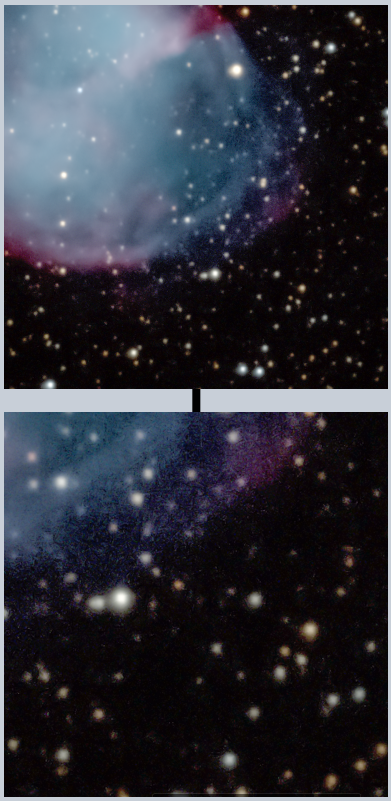


Fig. 21. The image with too much *noise reduction.* Detail loss is inherent in noise reduction to a degree, but the nebula has become much too blurred

Note: *Zooming in on these crops in the PDF may be beneficial depending on the resolution of your monitor.*

- Zoom out and play with the “Blacks” slider a bit to define the object edges as desired.
- Mess with overall exposure, highlights, shadows, and whites to suit your tastes. Only small adjustments should be needed, if any. In my test image, I increased exposure only a little bit, but if you had a really dim object going into Lightroom, raising this slider can make a huge difference (at the unfortunate expense of more noise, though).
- At this point, the image should look largely complete, so feel free to go back through any of the previous sliders that you changed and make further adjustments to get things looking as beautiful as can be.

  In my image of M27, for example, I went back and made the background a little bit less green, raised the contrast slider in the object’s radial filter, lowered exposure in this filter, lowered overall clarity, increased the temp a *tiny* bit overall (because things felt too blue), lowered the blacks again… It’s easy to spend *far* too long making small adjustments and changing sliders over and over, but you need to stop at some point or you risk over-editing it. You can always do another edit.

- Export (PNG recommended for versatility) that baby outta there and you’re done and free! Congrats!

Fig. 22.
The completed image of M27, the dumbbell nebula, exported as a jpeg (for sharing) from Lightroom