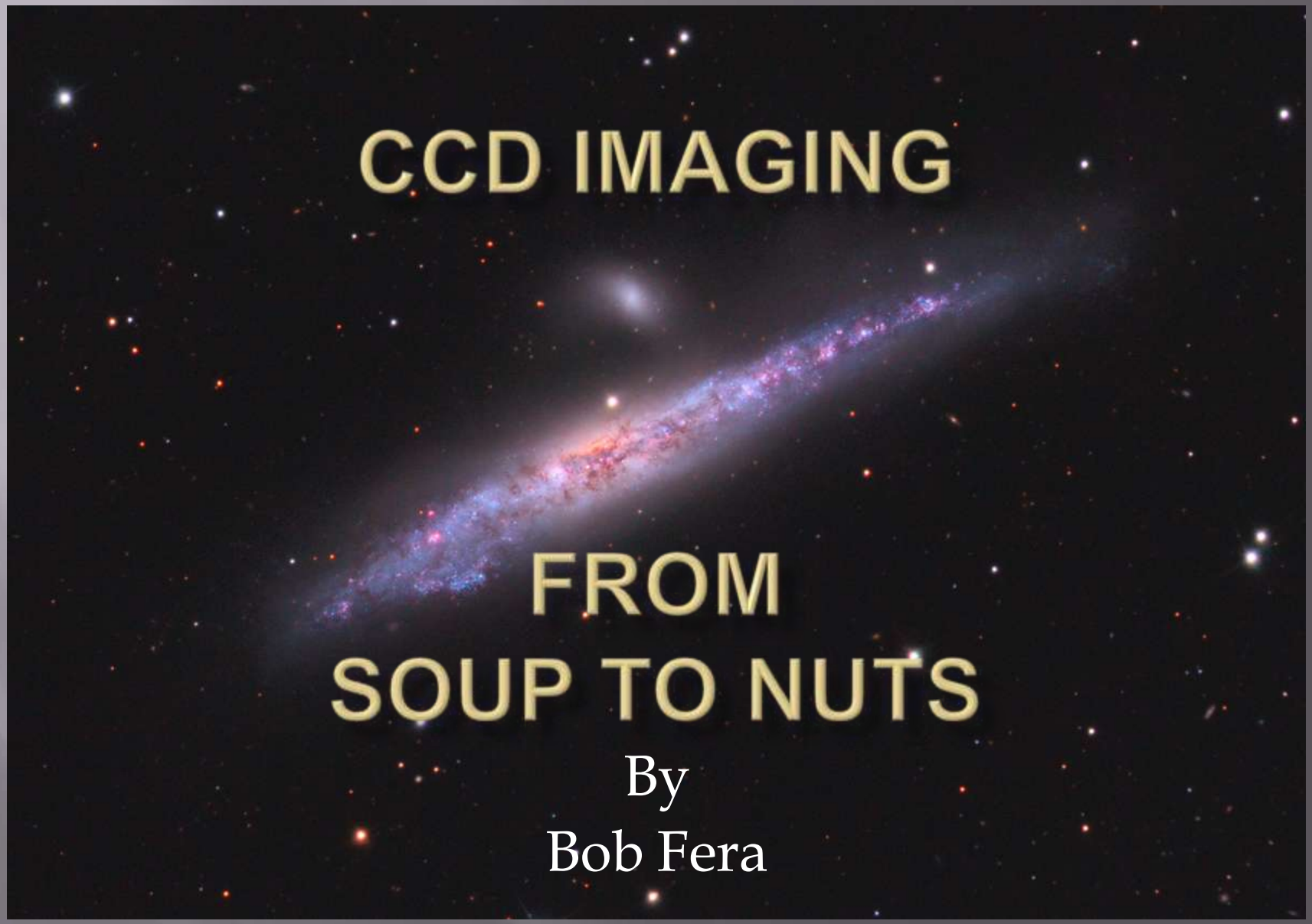

CCD IMAGING
FROM
SOUP TO NUTS
By
Bob Fera

Introduction

- Will try to touch on everything from equipment, software, and working at the telescope to image processing
- I don’t claim to have all the answers, or know all the “correct” techniques
- Image processing involves a lot of trial and error
- Remember that there’s always more than one way to skin a cat

Introduction

- Much image processing effort is spent overcoming limitations in our equipment and/or imaging site
- Sometimes there's only so much you can do!

Imaging Goals

- We have a lot of leeway in how the final image looks
- I try to bring out as much as I can without "crossing the line"
- My goal is for a "realistic" appearance that looks like a photograph

My Background

- Started shooting film in 1992
- It took until 1994 to get a system that was adequate for astrophotography and that performed reliably
- Most of my time has been spent using long focal length systems (~2800mm)
- Converted to CCD in 2003

My Equipment

- 14” f/8 A&M Ritchey Chretien
- Astro-Physics 1200GTO mount
- SBIG STL11000M Camera

My Equipment

- Other telescopes used over the years:
  - 8″ f/3.8 ASA Newtonian Astrograph
  - 4″ f/6.4 and f/8 Stellarvue Refractors
  - 6″ f/8 Stellarvue Refractor
  - 4″ f/8 William Optics Refractor
  - 12.5″ f/9 Parallax Ritchey Chretien
  - 8″ f/4.5 Newtonian
  - Celestron C-11

My Observatory

- I have a home observatory located at 2300 feet elevation in the Sierra Foothills
- Sky is dark to the east (magnitude 6+)
- Significant sky glow to the west so I can shoot objects only as they are rising
- Seeing is mediocre – a good night is 2-2.5” – with a lot of variability from shot to shot

Tools of the Trade

Equipment

- Lots of great choices today.
- Today's equipment actually works!
- Unfortunately, with quality comes cost.

Long Focal-Length Telescopes

- RC Optical Systems – top of the line Ritchey-Chretiens.
- A&M (Astrotech Engineering, Italy) – High end RC's that are much more affordable.
- Planewave Instruments – Relatively affordable Corrected Dall-Kirkham design that arguably out-performs RC's.
- Ceravolo – Dual-focal-length Corrected Dall-Kirkham.
- Vixen – Very low cost corrected Cassegrain that, with some modifications, produces excellent images.

Wide-field Telescopes

- Takahashi Refractors
- Televue Refractors
- Astro-Physics Refractors
- Stellarvue Refractors
- ASA Newtonian Astrographs

Mounts

- Probably more important than the telescope.
- Quality today is incredible, but expensive.
- Make sure the mount can EASILY carry the weight of the scope and instrumentation.

Mounts

- Bisque Paramount ME
- Astro-Physics
- Mountain Instruments
- Takahashi
- Mathis Instruments
- ASA

Cameras

- SBIG
- Apogee
- Finger Lakes Instrumentation
- Starlight Express

Image Acquisition Software

- MaxIm/DL
- TheSky6
- CCDSoft
- FocusMax
- CCDAutopilot

Image Processing Software

- CCDStack
- Adobe Photoshop CS
- Gradient Xterminator
- Focus Magic
- Noise Ninja
- Registar
- PixInsight LE

Image Acquisition

At the Telescope

- Lots of little things need to all work properly
- Need to minimize the chances for things to go wrong
- The better your raw data the easier it is to process

At the Telescope

- Need the basics of good collimation and good polar alignment
- Make sure the scope is well balanced on the mount (a little resistance is good)
- Give your optics time to cool down
- Avoid placing a heat source (e.g. your computer or you) under your line of sight
- Run a floor fan
- Run your telescope fans while shooting

At the Telescope

- For Cassegrain-type scopes, use an off-axis guider
- Tighten everything securely
- Attach cables to the scope to avoid drag

At the Telescope

Taking the Images

- I take the same duration sub-exposures for each of the color filters
- Go as long as you can and take as many as you can
- Typical sub-exposures are 15-30 minutes each
- If I have time I'll shoot color unbinned, otherwise bin 2x2
- Always dither your sub-exposures!
- Need to take darks, flats and biases

Focusing

- Get a good electronic focuser
- Use an automated focusing program such as FocusMax – it's free!

FocusMax

- Important that you get a good characterization of your system, called a V-Curve
- You need at least 8-12 good V-Curve runs to accurately characterize your system
- FocusMax will show you a table of the statistics it gathered for each run
- Delete the ones that deviate from the rest

Manual Focusing

- Choose a part of the image that has some faint stars
- Look for not only the highest brightness and lowest FWHM values, but also for when the faintest stars appear the tightest

Guiding

- I use MaxIm/DL v4 to control the camera
- Try to use a guide exposure of at least a few seconds to even out seeing effects
- Use the Autoguider Calculator on CCDWare's web site to determine min and max move settings
- Bin the guide chip 2x2 or even 3x3 if the guide star is faint
- Lower the aggressiveness if seeing is bad

Automation

- CCDAutopilot
- CCD Commander
- ACP

CCDAutopilot Demo

Image Processing

Basic Processing Flow

- Create master Bias
- Create master Dark
- Create master Flats
- Calibrate light frames
- Debloom if necessary
- Upsample binned color frames if necessary
- Align light frames
- Normalize, Data Reject and Combine light frames

Basic Processing Flow

- Optionally deconvolve luminance
- Save FITS versions of deconvolved and non-deconvolved image
- Tweak DDP parameters and save scaled 16-bit TIFF versions
- Combine R, G and B files into a color image
- Save FITS version
- Tweak DDP parameters and save scaled 16-bit version

Basic Processing Flow

- Open luminance in Photoshop
- Remove gradients if necessary
- Clean up artifacts if necessary
- Adjust Levels and Curves
- Save and close luminance

Basic Processing Flow

- Open color file in Photoshop
- Remove gradients if necessary
- Clean up artifacts if necessary
- Smooth color noise if necessary
- Adjust Levels and Curves
- Save color file

Basic Processing Flow

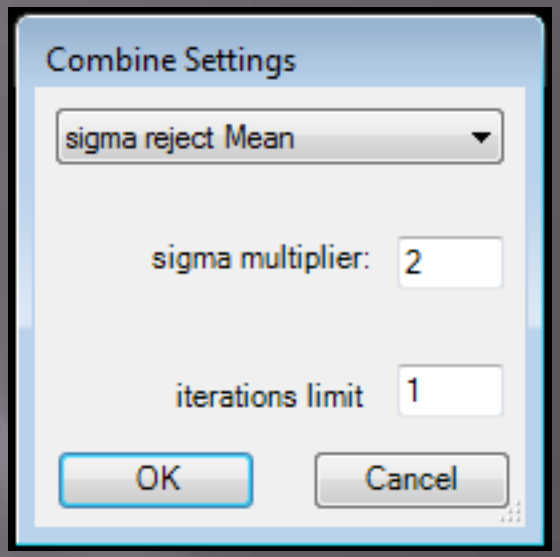
- Flatten color image
- Open luminance image and flatten
- Copy luminance and paste on top of color, creating a new layer
- Close luminance image (don’t save)
- Change blending mode of luminance layer to “Luminosity”
- Begin tweaking!

Image Processing

Phase 1: CCDStack

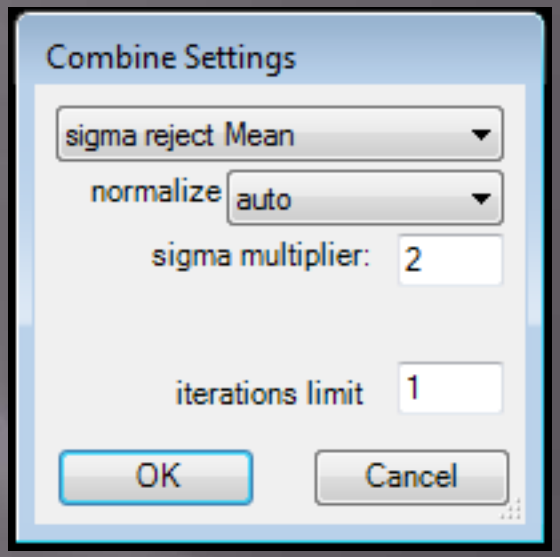
Calibration

- Create a Master Bias
- Use Sigma Reject Mean as the combine method



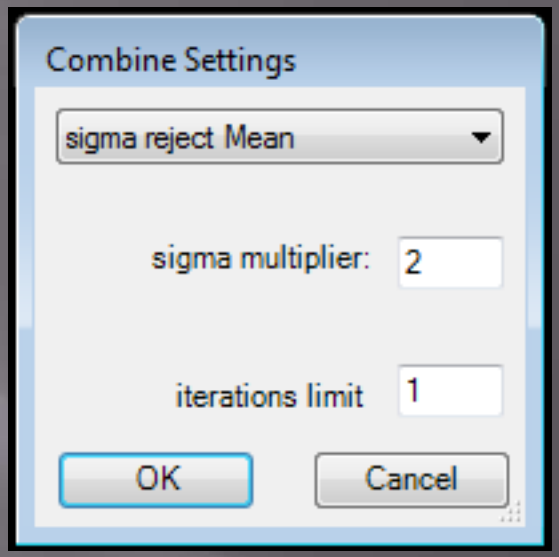
Calibration

- Create master Flats
- Subtract the Bias
- Use Sigma Combine Mean



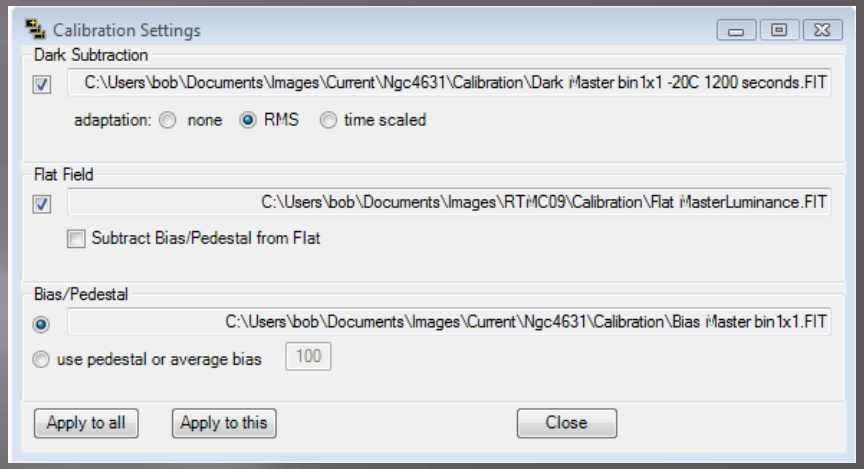
Calibration

- Create Master Dark
- Use Sigma Reject Mean



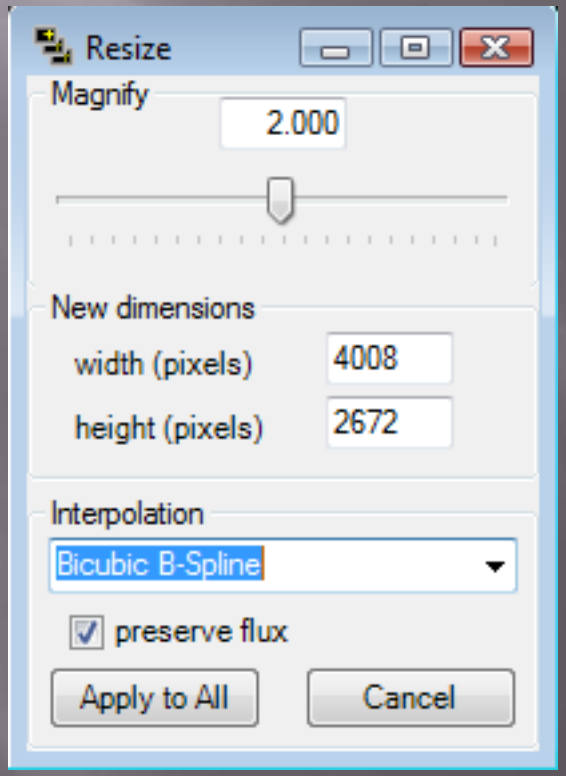
Calibration

- Calibrate your light frames
- Choose the RMS option to adjust for minor temperature variations



Resizing

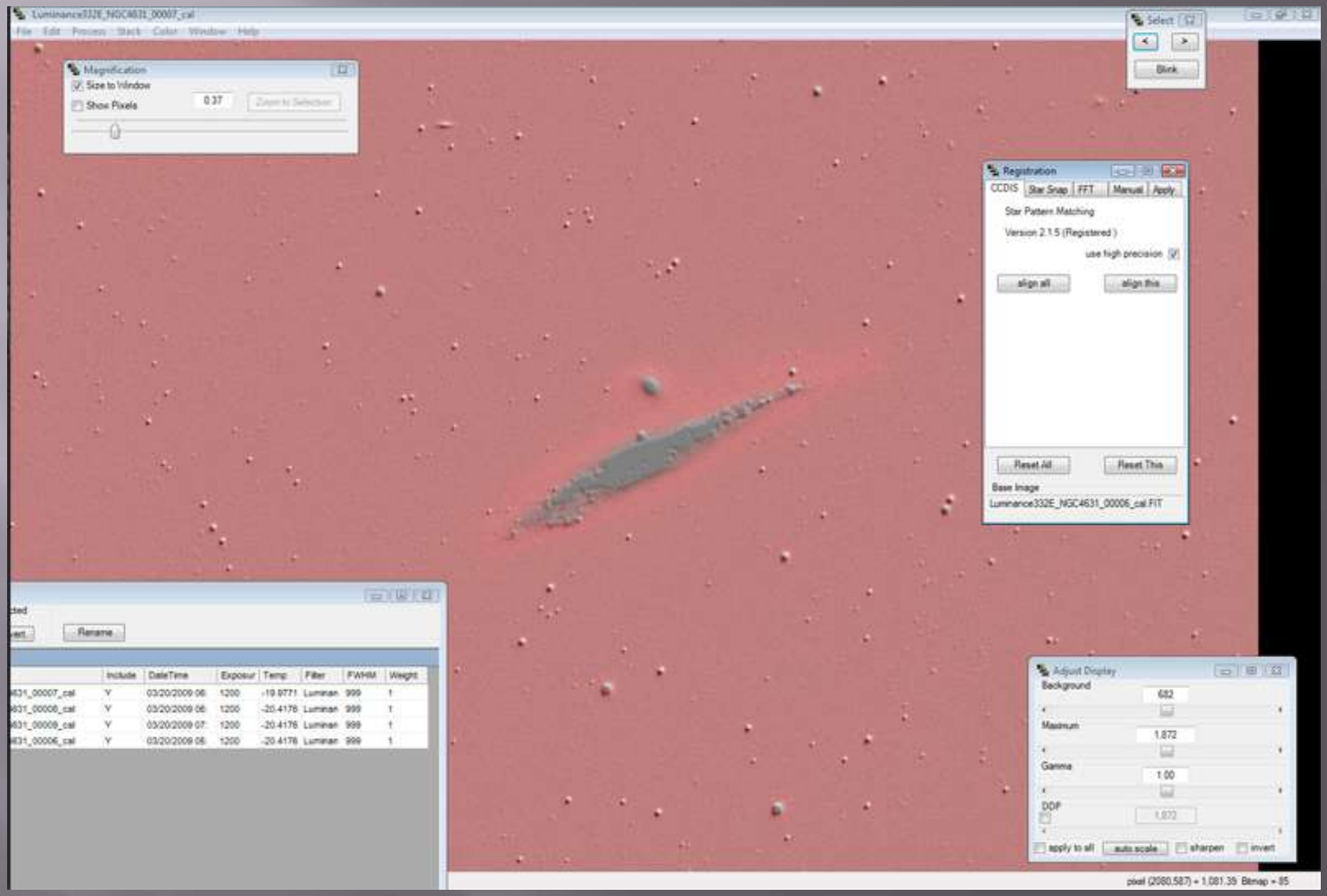
- Upsample your binned color images using Bicubic B-Spline interpolation



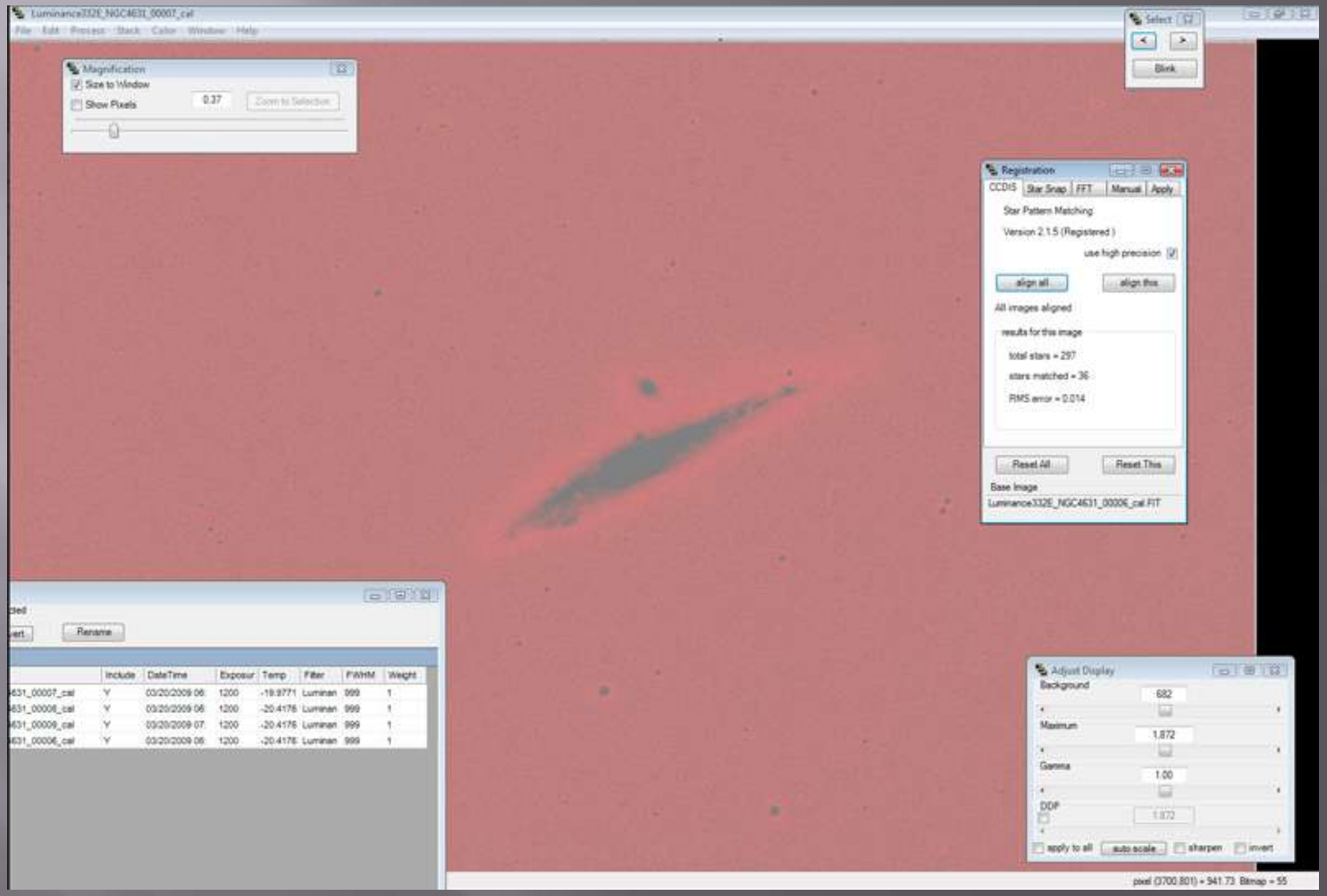
Alignment

- Highly recommend the CCDInspector plug-in
- Pick one image and align all your light frames to it
- Align images only once – each alignment process loses data

Alignment

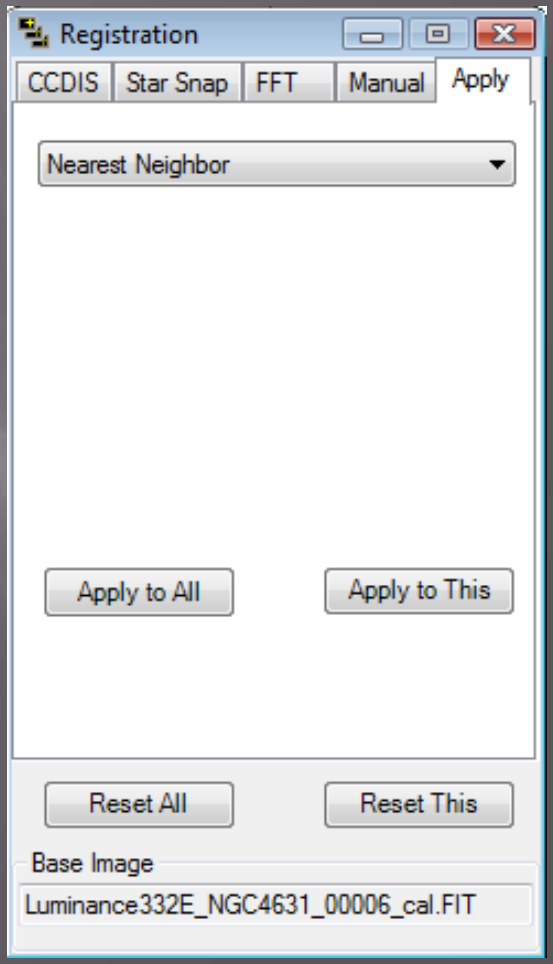

Magnification
Size to Window
Show Pixels
0.37
Select
Blink
Registration
CCDIS
Star Snap
FFT
Manual
Apply
Star Pattern Matching
Version 2.1.5 (Registered)
use high precision
align all
align this
Reset All
Reset This
Base Image
Luminance332E_NGC4631_00006_cal.FIT
Rename
Include
DateTime
Exposur
Temp
Filter
FWHM
Weight
Adjust Display
Background
682
Maximum
1.872
Gamma
1.00
DDP
apply to all
auto scale
sharpen
invert

Alignment


Magnification
Size to Window
Show Pixels
0.37
Zoom to Selection
Select
Blink
Registration
CCDIS
Star Snap
FFT
Manual
Apply
Star Pattern Matching
Version 2.1.5 (Registered)
use high precision
align all
align this
All images aligned
results for this image
total stars = 297
stars matched = 36
RMS error = 0.014
Reset All
Reset This
Base Image
Luminance332E_NGC4631_00006_cal.FIT
Rename
Include
DateTime
Exposur
Temp
Filter
FWHM
Weight
Adjust Display
Background
682
Maximum
1,872
Gamma
1.00
DDP
apply to all
auto scale
sharpen
invert

Alignment

- On "Apply" tab, choose "Nearest Neighbor"
- Will keep stars the sharpest and allow the combine algorithm to clean things up



Alignment Detour: Registar

- Nothing is better for mosaics
- Always use a wide field shot – even a low res one you find on the internet – as a base
- It will adjust your mosaic panes to overlay the base image and register them perfectly

Combining Subframes

- Normalization
- Data Rejection
- Combination

Normalization

- Choose Stack->Normalize->Control->Both
- Draw a box around a background area
- Draw a box around a non-saturated highlight area

Data Rejection

- Use either STD Sigma Reject or Poisson
- I've generally had better luck with STD, but it likes to have a larger number of images
- Target a "top image %" of 1-2%
- CCDStack shows you all the rejected pixels
- You can manually reject areas that are not picked up by the algorithm

Combination

- Use either Mean or Sum
- Stan says the S/N is the same, so it doesn't really matter which you choose

Combination

SINGLE FRAME

MEAN-COMBINED

DDP

- CCDStack has a “live” DDP that allows you to see parameter changes instantly
- Once you have the image looking the way you want, drop the black point by 30-50 points to avoid clipping the blacks
- Save as a “scaled” 16-bit TIFF for Photoshop

Demo

Deconvolution

- Use to tighten up stars and sharpen detail, especially in galaxies
- To tighten stars, use Positive Constraint and about 30-50 iterations
- To sharpen detail, perform a second, stronger decon with more iterations
- Any decon can “curdle” your background

Deconvolution

- If you have very good S/N, to sharpen a galaxy try 200-300 iterations of Maximum Entropy
- This can enhance your detail, but you can also overdo it
- Maximum Entropy will destroy your stars!

Deconvolution

- Save each version of your image (Strong, Mild and non-deconvolved) as a 32-bit FIT
- Use the “apply to all” option on the DDP screen to stretch each version identically
- Save each as a scaled 16-bit TIFF
- We will use the best of each version once we get into Photoshop

Combining Color – G2V Balance

- Need to know the G2V balance for your telescope/filter/camera combination
- CCDAutopilot4 can do this for you automatically!
- To do it manually, center a G2V star that's high in the sky
- See http://www.kellysky.net/artdraf7.htm for a small catalog of G2V stars

G2V Balance

- Take a few short equal length images of the G2V star through each filter, making sure not to saturate the detector
- Use the measuring tool in MaxIm/DL to measure the “Intensity” of the star in each image
- Average the values for each filter

G2V Balance

- Divide the Red value into the Green and take the inverse
- Do the same for the Blue
- That's it! You have your G2V weights
- $Wr = 1/(R/G) = G/R$
- $Wg = 1$
- $Wb = 1/(B/G) = G/B$

Extinction Factor

- The other item you need to create accurate color is the Extinction Factor, based on the altitude of your target
- Determine the average altitude of the target for each color
- Find the Extinction Factor multipliers available on the earlier web page or in *The Handbook for Advanced Image Processing*
- Multiply your G2V weights by the appropriate factors

Combining Color

- Open the Red, Green and Blue images in CCDStack
- Choose Color->Create, type in your corrected G2V ratios and click Create
- Select a small piece of the background so CCDStack can balance it
- Try increasing the saturation slider to 1.15 or 1.20

Combining Color

- Apply DDP as with Luminance, again making sure to lower the black point to avoid clipping
- Save as a 16-bit TIFF
- Note that you can apply a light deconvolution to the Red, Green and Blue files before combining to help match the RGB star sizes to your Luminance

Demo

Image Processing

Phase 2: Photoshop

Before You Begin

- CALIBRATE YOUR MONITOR!!!
- I use a Gretag-Macbeth Eye One
- Spyder-2 is another popular choice
- Includes a hardware device that measures the output of your monitor
- Helps you set brightness and contrast to standardized values
- Creates an ICC profile that corrects the color

General Suggestions

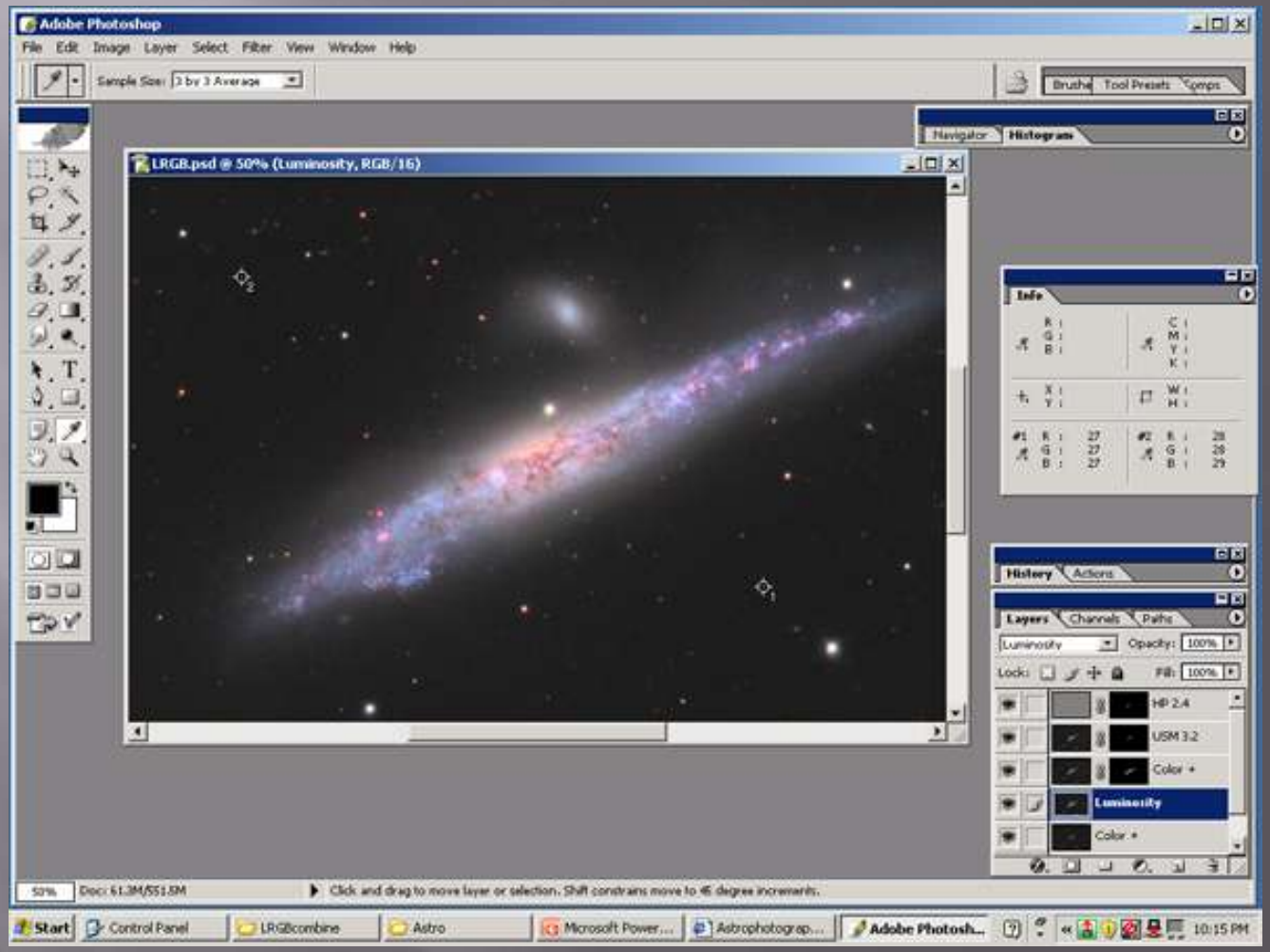
- Use a gentle hand with anything you do
- Avoid clipping the blacks at all costs
- Use Curves and Levels for most tonal adjustments
- Sky background should be 20-30, i.e. dark gray, not black
- Make non-destructive edits whenever possible
- Use Adjustment Layers and CAB Layers
- This allows you to undo changes and also apply them to parts of the image after the fact

Photoshop Tools and Adjustments

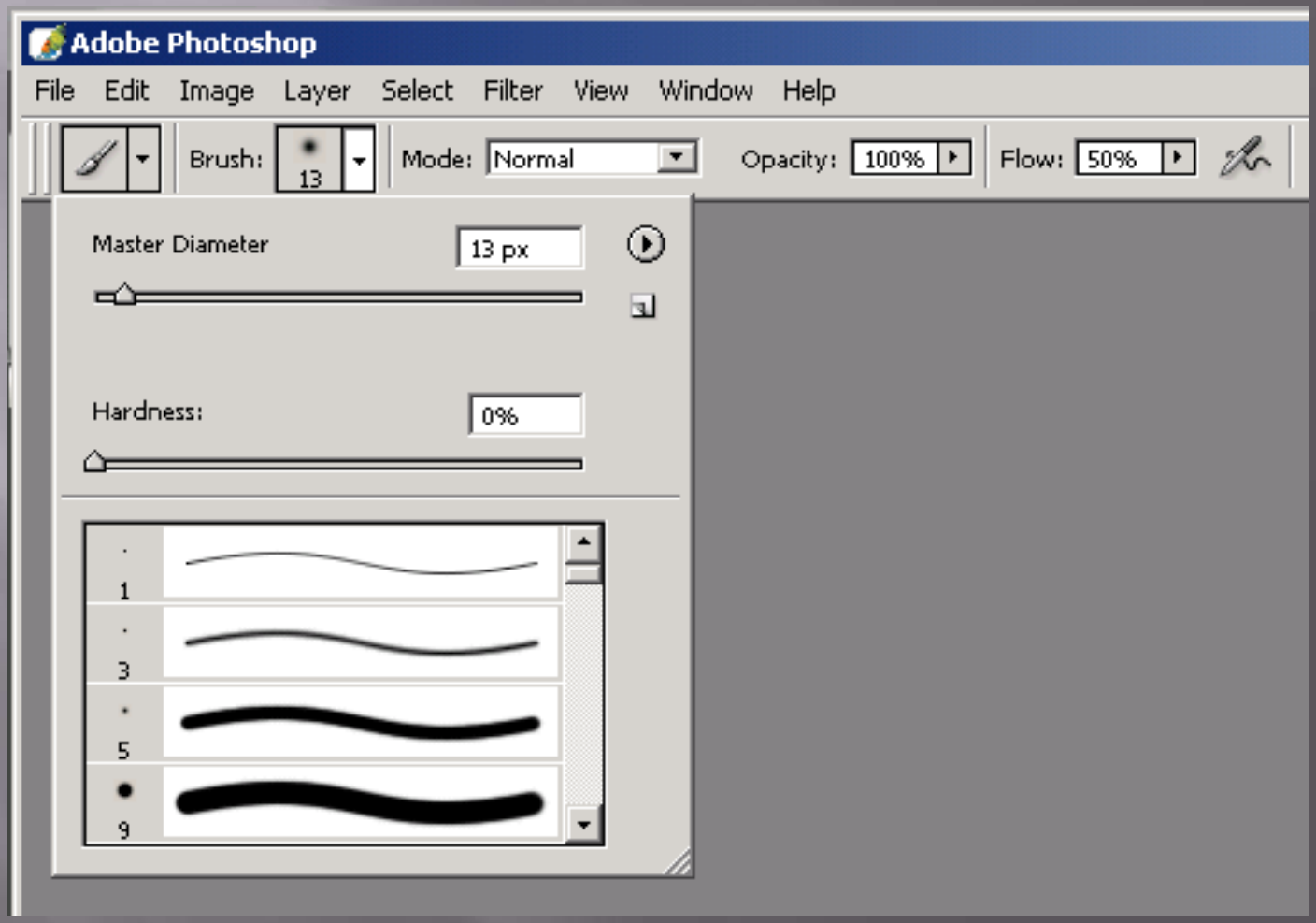
Eyedropper

- Used to take samples of a portion of your image
- Normally use a 3x3 average pixel sample
- A few special cases may call for a point source
- Use Shift-Click to place a sample point on your image (value displays in Info palette)
- Use Ctrl-Click when the Curves dialog is open to place points on the curve

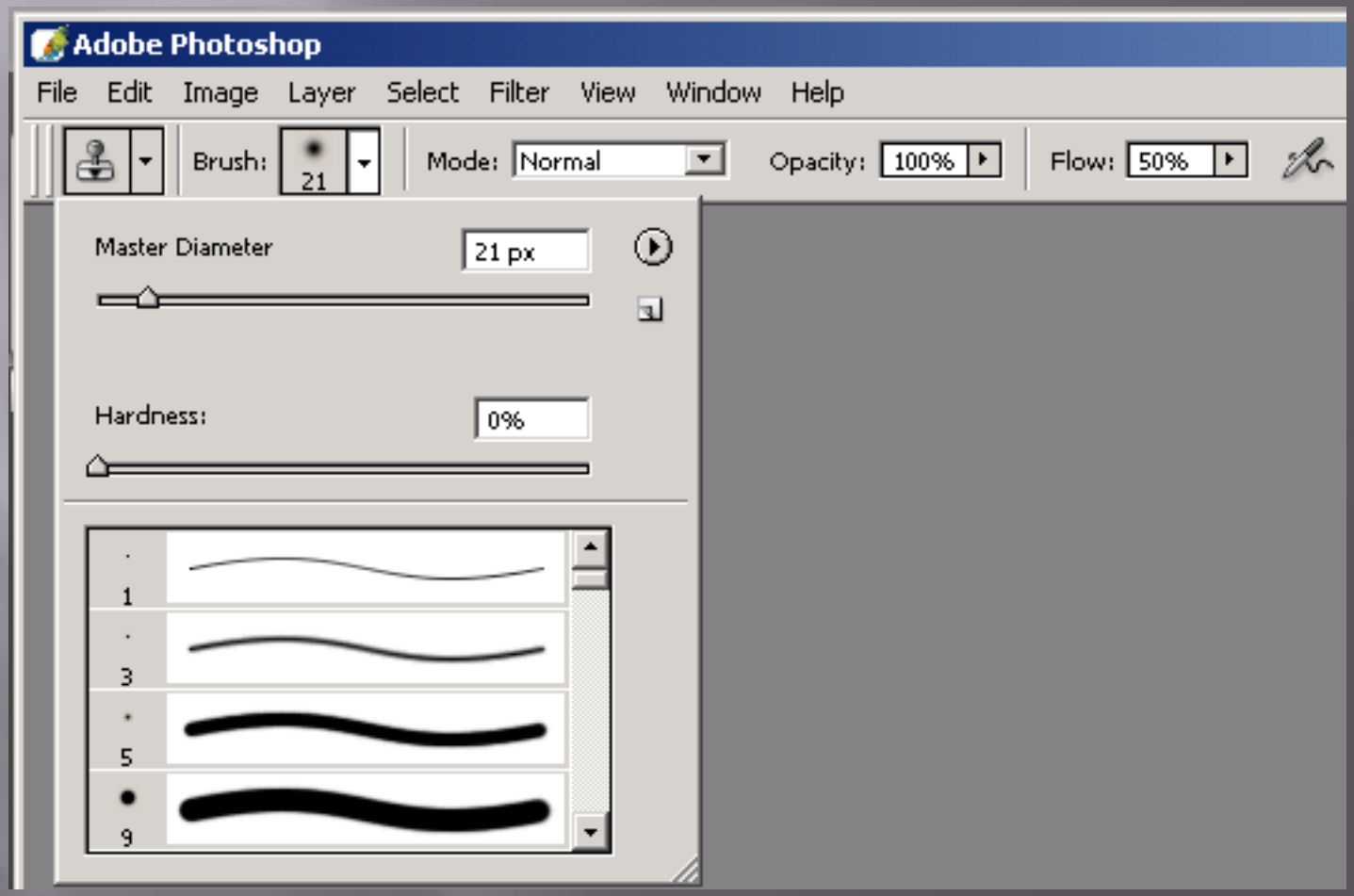
Eyedropper


Adobe Photoshop
File Edit Image Layer Select Filter View Window Help
Sample Size: 3 by 3 Average
Brushes Tool Presets Comps
Navigator Histogram
LRGB.psd @ 50% (Luminosity, RGB/16)
Info
History Actions
Layers Channels Paths
Luminosity
Opacity: 100%
Lock:
Fill: 100%
HP 2.4
USM 3.2
Color +
Luminosity
Color +
50%
Doc: 61.3M/551.5M
Click and drag to move layer or selection. Shift constrains move to 45 degree increments.
Start
Control Panel
LRGBcombine
Astro
Microsoft Power...
Astrophotograp...
Adobe Photosh...
10:15 PM

Paintbrush


Adobe Photoshop
File
Edit
Image
Layer
Select
Filter
View
Window
Help
Brush:
13
Mode:
Normal
Opacity:
100%
Flow:
50%
Master Diameter
13 px
Hardness:
0%
1
3
5
9

Clone Stamp Tool



Clone Stamp Tool

- Alt-click to choose the sample point
- Click and hold to “paint” the sample point onto a new spot
- Sample point moves relative to where you are “painting”

Healing Brush (Band-aid) Tool

- Like the Clone Stamp Tool, it is also used to repair imperfections by painting a sampled portion of the image to another spot
- It matches the texture, lighting, transparency and shading
- Use the same technique of Alt-clicking to sample and then painting on the area to be repaired
- Set Mode to “Replace”

Dodge Tool

- Use to lighten portions of the image
- Use very sparingly
- I always set the strength very low (5%)
- Set the dropdown menu to “midtones” and use it on tiny faint background galaxies

Burn Tool

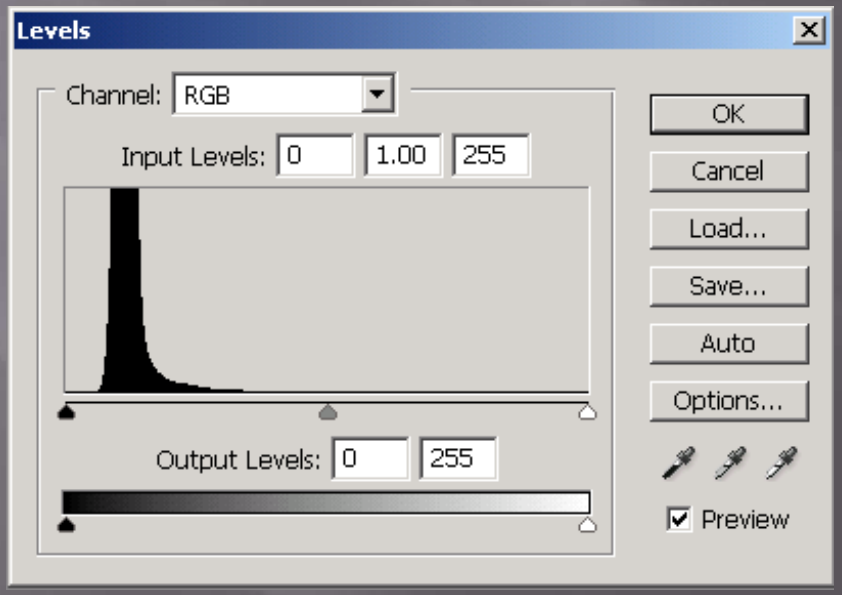
- Use to darken portions of the image
- Use very sparingly
- Set strength very low (5%)
- Choose "shadows" from the dropdown to darken/emphasize dust lanes
- Choose "midtones" to try to recover blown out highlight areas – sometimes works on bright HII regions in galaxies (NGC 604 in M33 for example)

Sponge Tool

- Use to saturate or desaturate portions of the image
- My most common use is to desaturate spots that end up “overcooked” because of other processing effects

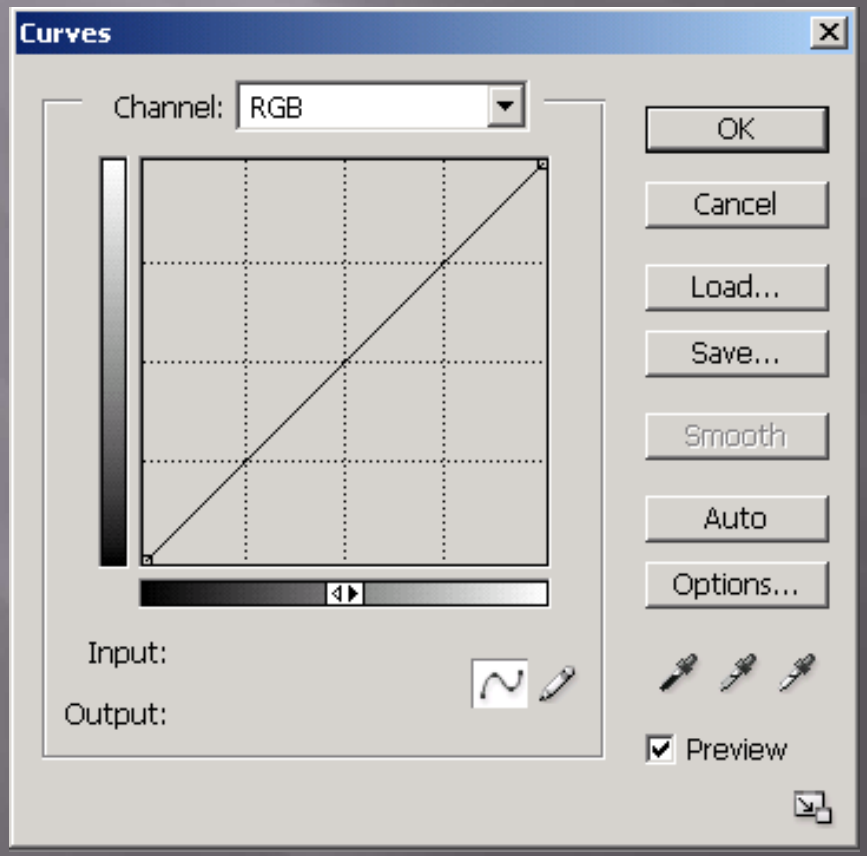
Levels

- I usually use Levels only to raise the black point of an image
- Always remember to leave some space below the left end of the histogram to avoid clipping the blacks



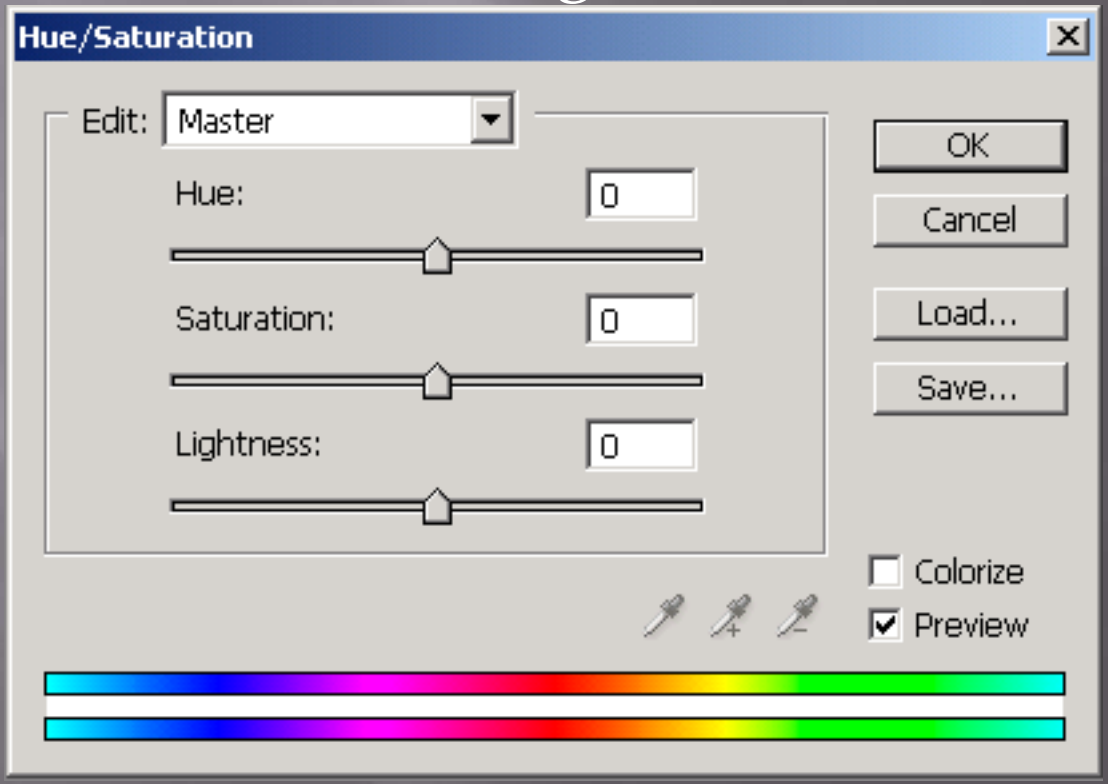
Curves

- Curves is your most powerful tonal adjustment tool



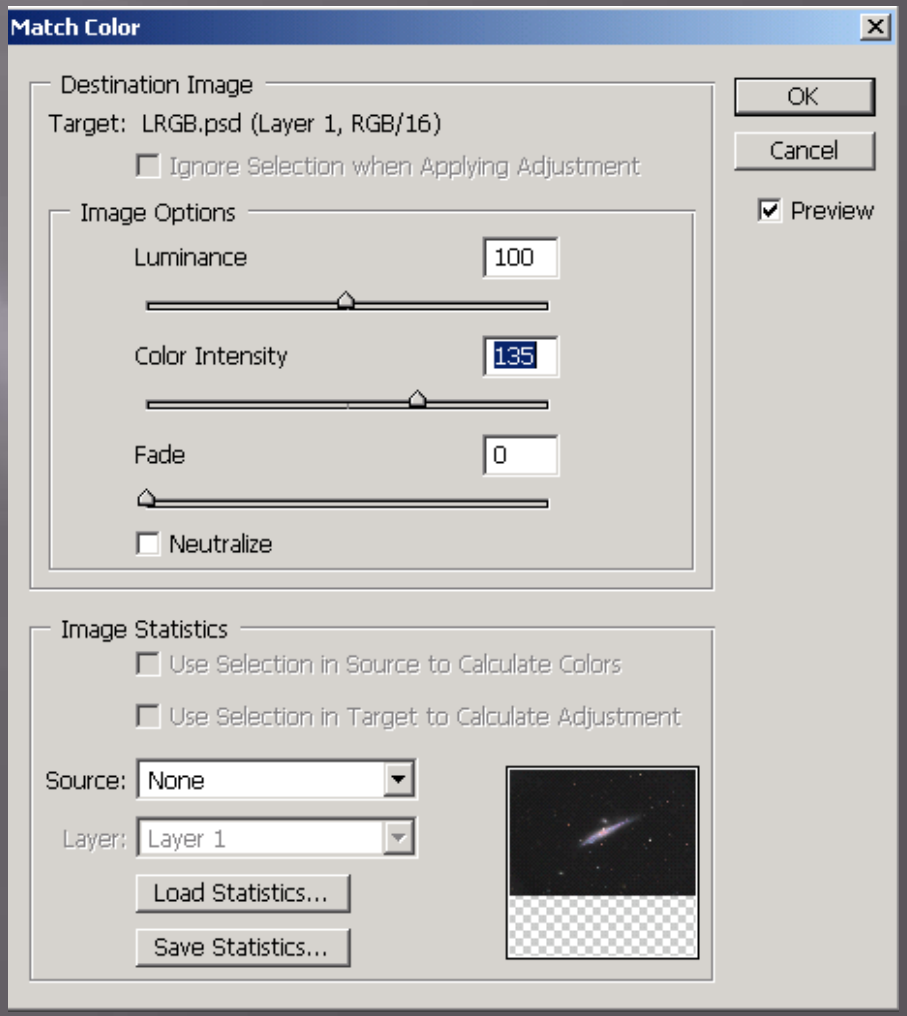
Hue/Saturation

- Used for adjusting the saturation of an image, but there is a better way
- Also used for colorizing narrowband images



Match Color

- A great way for increasing saturation while minimizing color noise
- Simply increase the "Color Intensity" slider

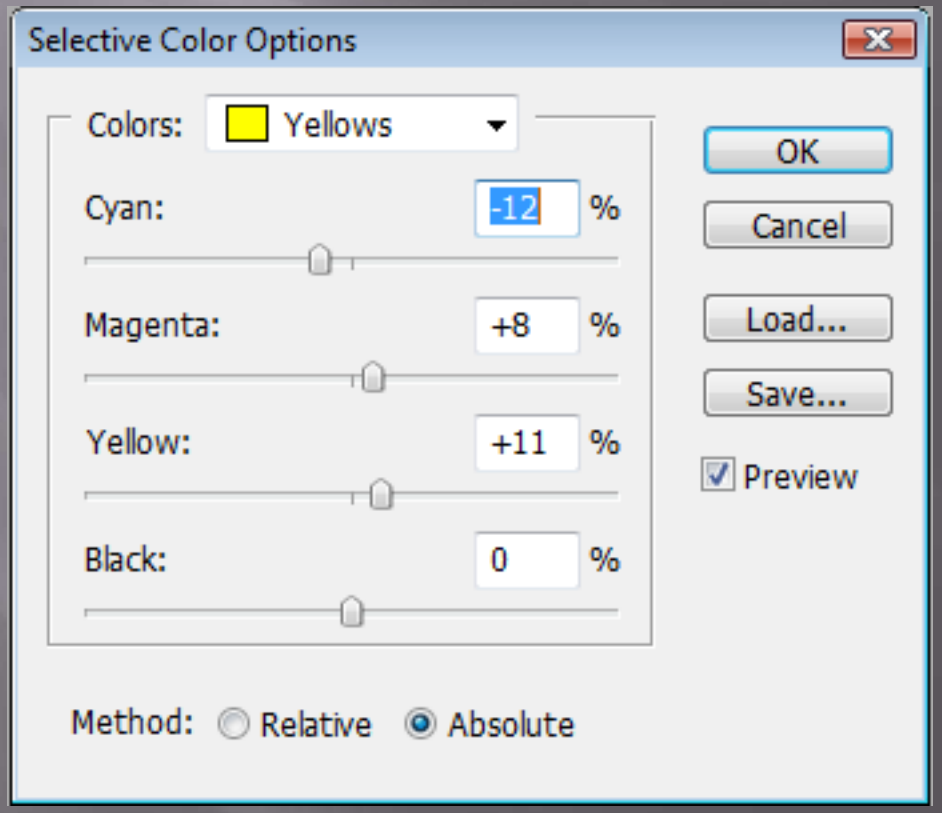


Selective Color

- Use Selective Color to make subjective color tweaks such as making reds more magenta, blues more cyan, etc.
- Also good for removing some kinds of color noise

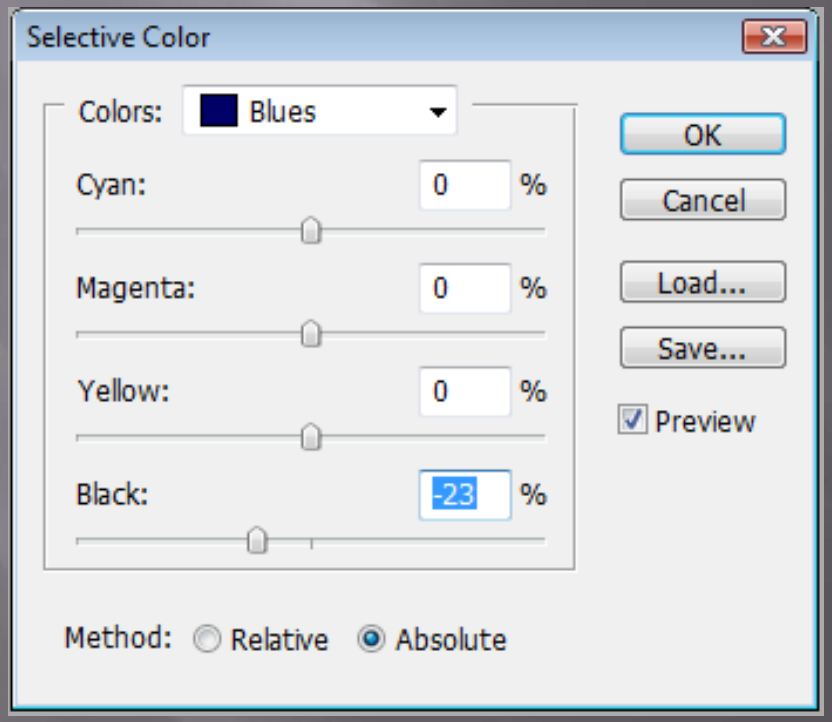
Selective Color

- Here's an example of adjusting the yellows in the core of a galaxy…



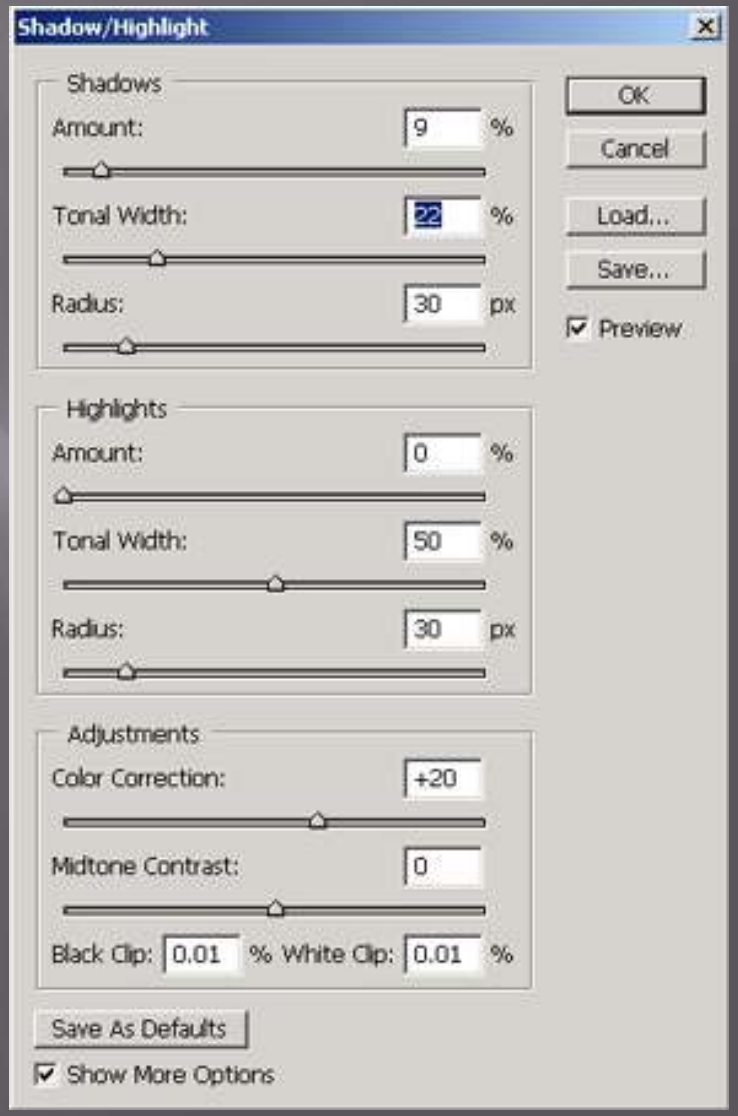
Selective Color

- You can also use Selective Color to lighten or darken a particular color by subtracting or adding “black”
- Can be good for bringing up faint blue arms in a galaxy



Shadow/Highlight

- Can be very effective on selected shots with faint nebulosity
- Also good for toning down very bright galaxy cores



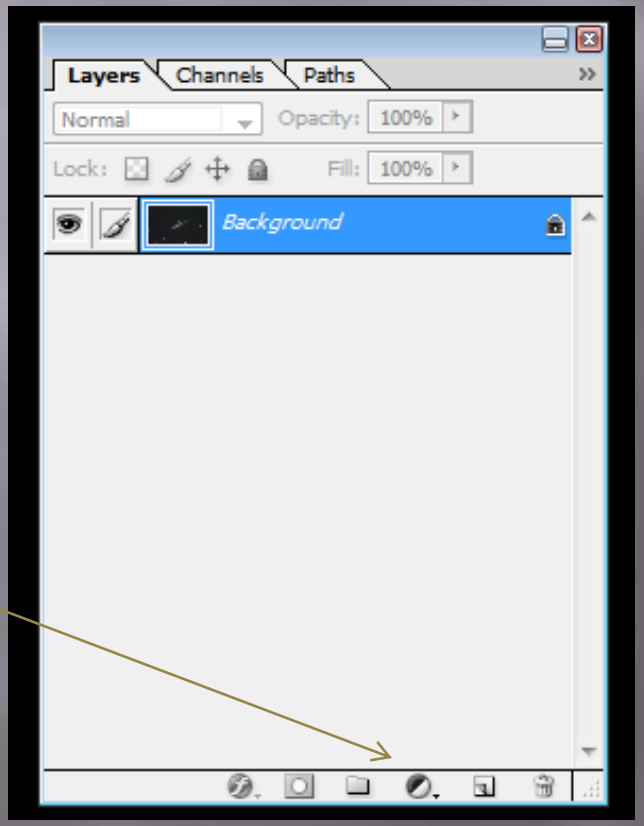
Making Adjustments

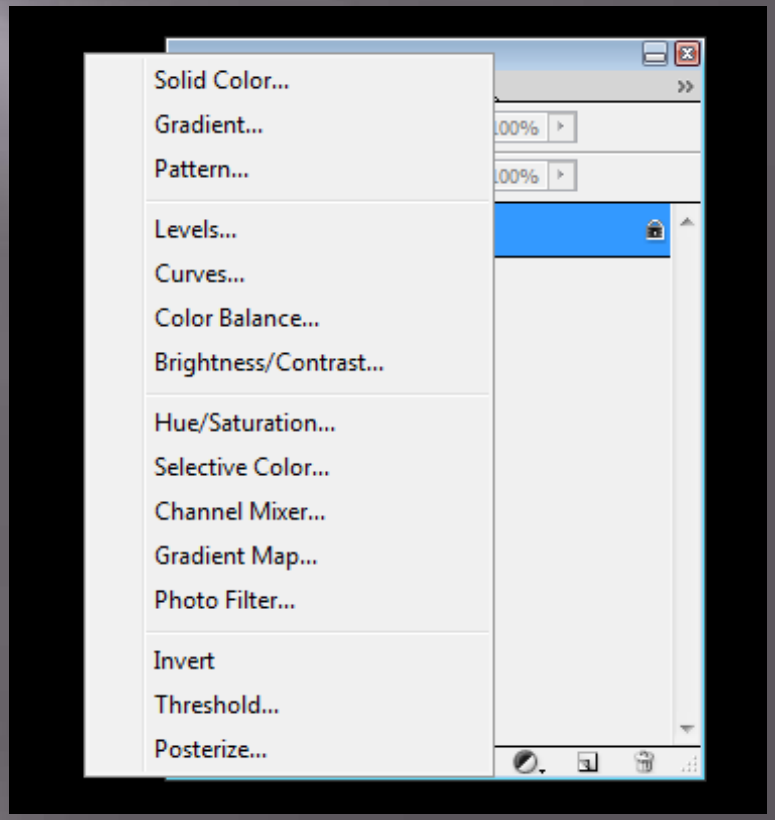
- Always make your adjustments using layers
- This helps keep your edits non-destructive, i.e. easier to undo

Layer Example

Adjustment Layers

- Use Adjustment Layers whenever Photoshop lets you





CAB Layers

- Some operations cannot be done with Adjustment Layers
- Filters, some Adjustments, Tools
- Create a CAB ("Contains All Below") Layer to make these edits
- Ctrl-Alt-Shift N E
- This creates a new layer that is a blend of all layers below it

Selections

- Many times you don’t want to make changes to the entire image
- Selections allow you to make changes to a portion of your image
- Photoshop gives you many ways to pick what you want to work on

Lasso Tool

- Most common selection tool is the free-form Lasso Tool
- Allows you to draw a curved line around what you want to select
- Always feather your selection so that adjustments will blend better
- For large selections (e.g. a whole galaxy), set the feather to 50-100 pixels

Magic Wand

- Great for selecting things like the sky background
- Set sample size on the Eyedropper tool to 3x3
- Set Tolerance to around 5
- Click on the background
- It will select pixels similar to what you clicked on
- If you want to add to the selection, Shift-Click
- If you want to remove areas from the selection, Alt-Click

Color Range

- Look for Color Range in the Select menu
- Allows you to make selections based on the color of the pixels
- Set Eyedropper sample size to point source
- Set Fuzziness as needed
- Zoom in and click on specific pixels
- Shift-Click to add to the selection

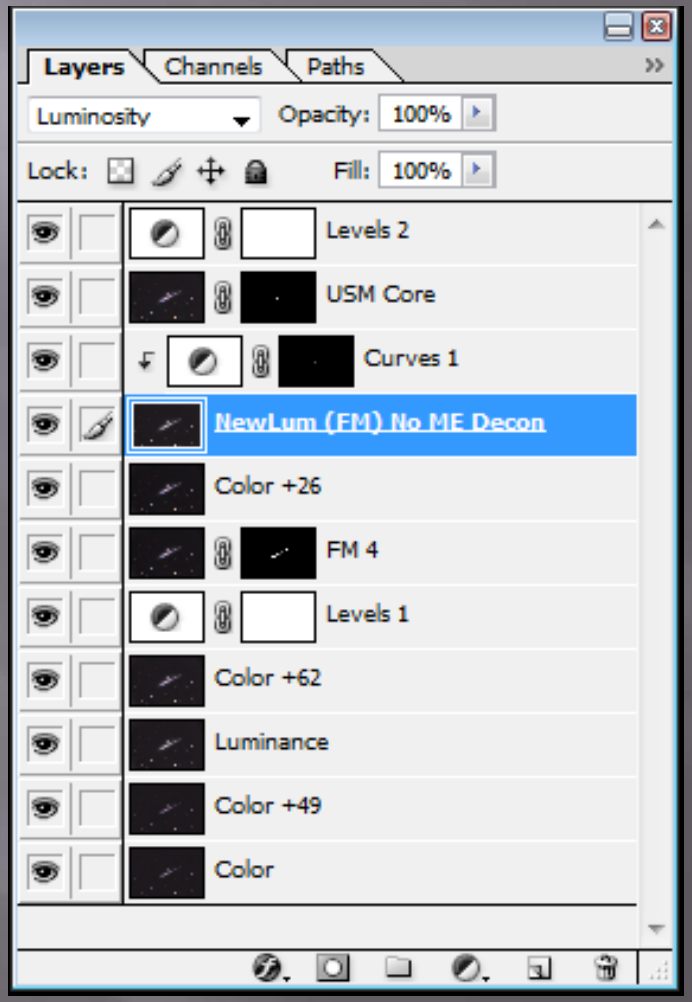
Layer Masks

- Allow you to apply adjustments to specific parts of your image with complete control EASILY
- A Layer Mask in Photoshop is a grayscale image that is associated with each layer in the file
- White means that part of the layer is visible, while black means it is invisible
- Shades of gray allow some of the layer to show

Layer Masks

- If you use a Selection Tool (e.g. Lasso), then create an Adjustment Layer, Photoshop will automatically turn the selection into a Layer Mask
- Layers that have Masks display a thumbnail image of the mask on the Layer palette

Layer Masks


Layers
Channels
Paths
Luminosity
Opacity: 100%
Lock:
Fill: 100%
Levels 2
USM Core
Curves 1
NewLum (FM) No ME Decon
Color +26
FM 4
Levels 1
Color +62
Luminance
Color +49
Color

Layer Masks

- You can see a Layer Mask directly by Alt-clicking on the Layer Mask thumbnail

Layer Masks

- Because Layer Masks are themselves grayscale images, you can manipulate them with Photoshop tools, adjustments and filters
- For example, you can “paint” on a black Layer Mask (which hides the layer) with a white paintbrush to make the corresponding part of the layer visible

Specific Tasks

Image Cleanup

Gradients

- You open your stretched color image and it looks like this:

Gradients

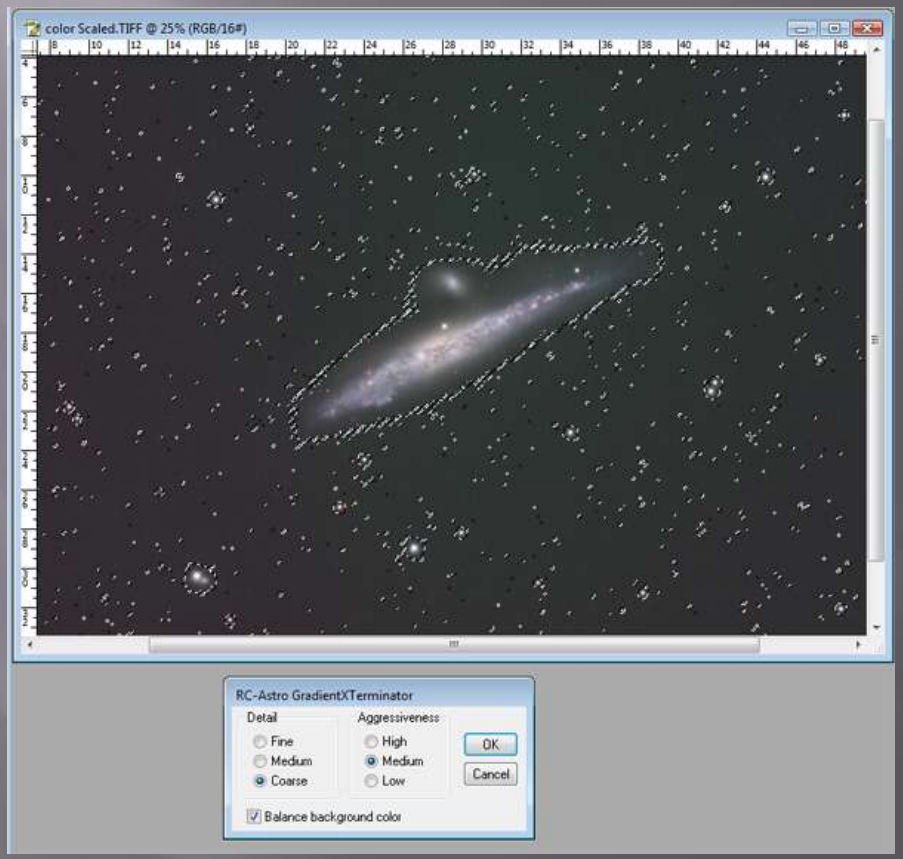
- Gradient XTerminator to the rescue!
- Photoshop plugin written by Russ Croman
- www.rc-astro.com
- An essential tool in your arsenal

Gradient XTerminator

- Set Eyedropper sample to 3x3
- Choose the Magic Wand tool
- Set Tolerance to 5
- Click on the sky background
- Shift-click on areas that the Wand missed to get the whole sky
- If the selection gets too close to your target, use the Lasso Tool to deselect the area you want (hold the Alt button while using the tool)

Gradient XTerminator

- Run the Gradient Xterminator filter



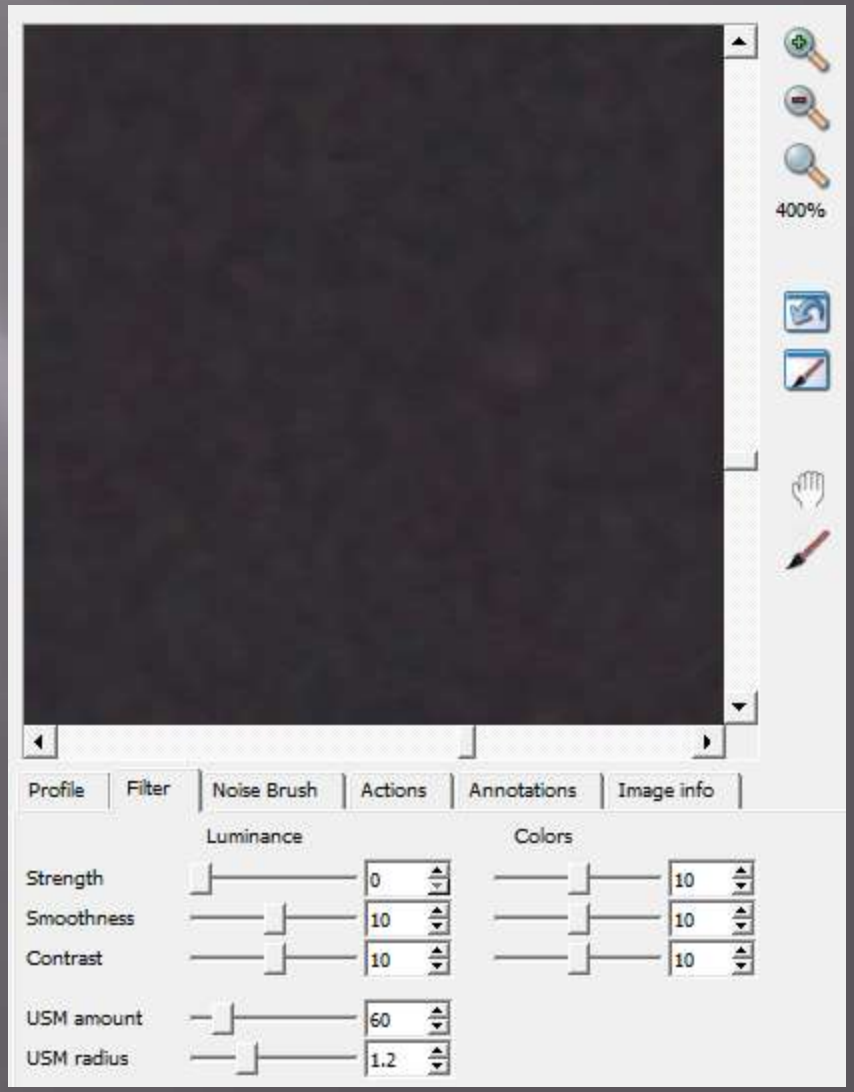
Gradient XTerminator

Color Noise

- RGB images are frequently polluted with color noise

Color Noise

- I use Noise Ninja
- Apply color noise reduction



Cleaning up Artifacts

- Take the time to go through the entire image and get rid of unwanted junk
- Use the Clone Tool (Rubber Stamp) at high opacity or the Healing Tool (Band-Aid)

Color Reflections

Color Reflections

- Choose the Clone (Rubber Stamp) Tool
- Set the mode to Color and opacity to 100%
- Clone the surrounding color onto the halo
- The halo will still be there, but it will be easier to clone out because its color now blends with the surrounding area

Color Reflections

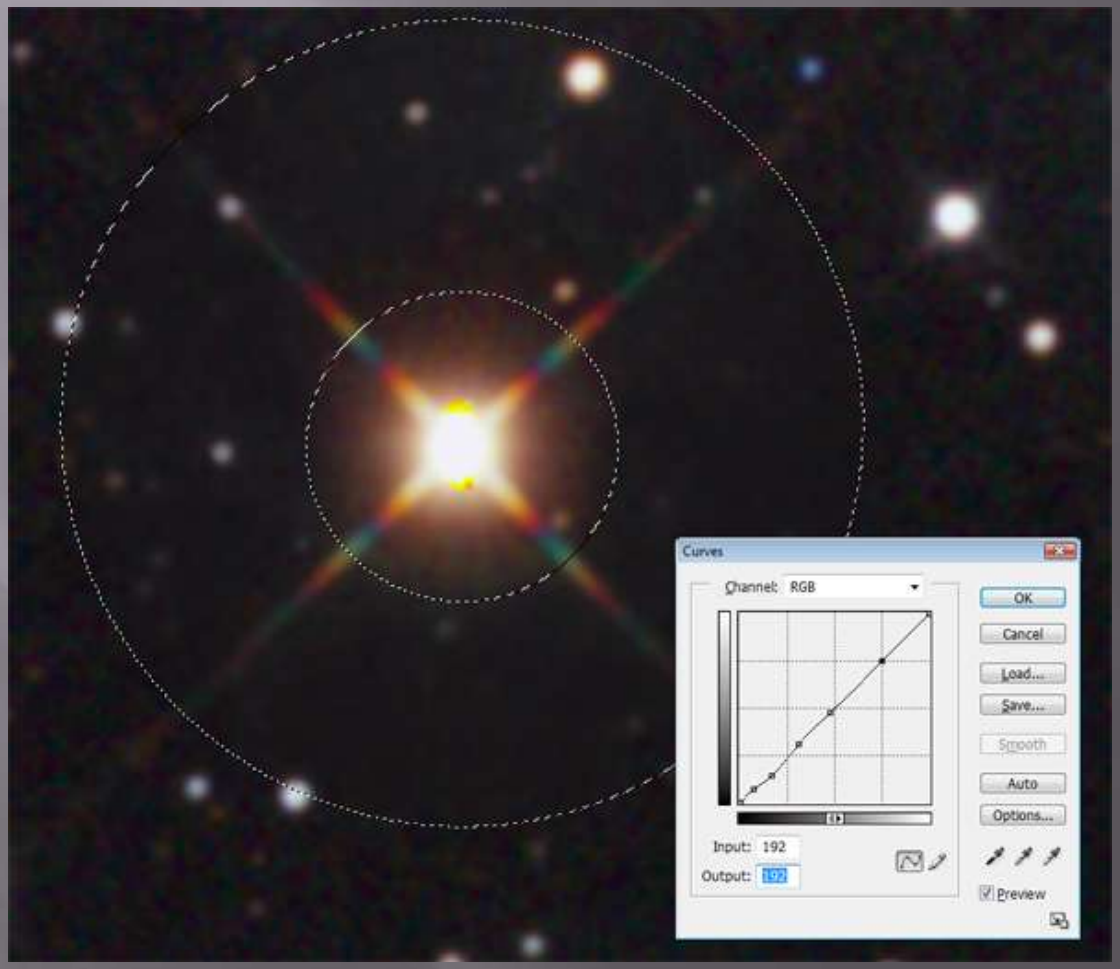
Color Reflections

- Change the mode of the Rubber Stamp to Normal
- Drop the Opacity (50%?)
- Make sure Hardness is 0
- Clone out the halo
- You can also experiment with the Healing (Band-Aid) tool, which will do a better job of preserving the texture

Color Reflections

Color Reflections

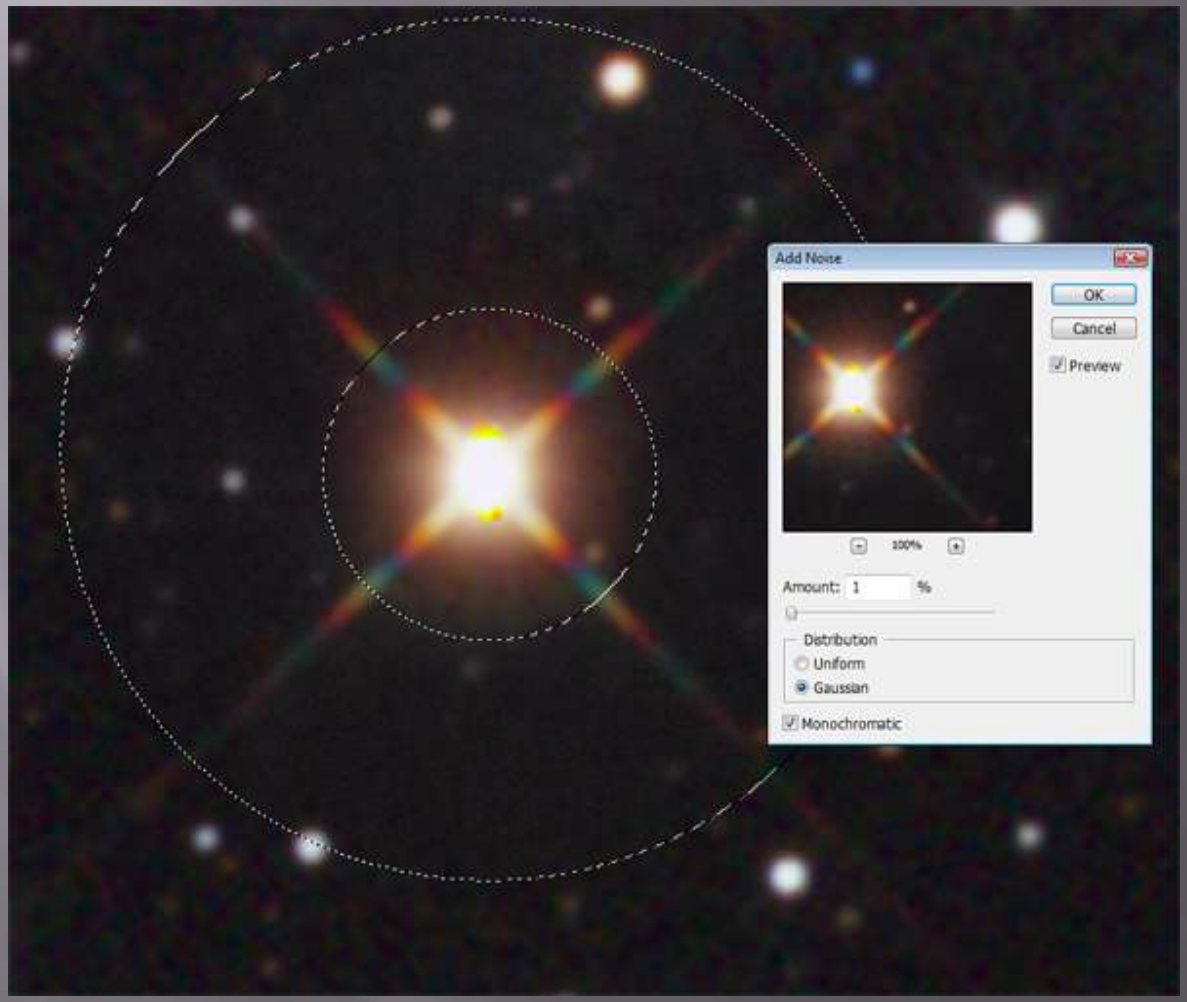
- Try Curves to darken the reflection



Color Reflections

- An unwanted side effect of all this is that the repaired area can end up looking smoother than the surrounding area
- Try adding some noise!

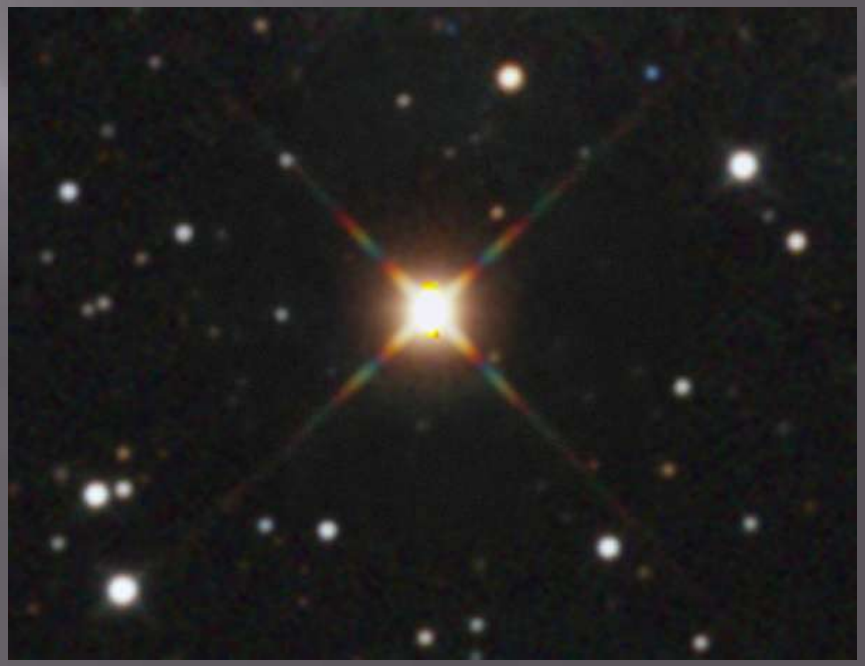
Color Reflections



Color Reflections

BEFORE

AFTER



Color Reflection

- This is how I've always done it, but maybe there's a better way…
- Set the Healing Brush to "Replace" mode and just stamp out the halo
- Use the Clone tool with low opacity to keep the transition around the edge of the star smooth
- This technique is easier and preserves the texture better

Demo

Image Cleanup - Final Thought

- It’s tedious
- Good to do early in the process
- If you decide to reprocess your image and you performed cleanup at the end, you’ll have to redo it!

Luminance

- Assume we have saved deconvolved and non-deconvolved (plain) versions of our Luminance data
- Open both versions in Photoshop
- Select the deconvolved version (Ctrl-A), copy it to the clipboard (Ctrl-C) and close the file
- Paste it onto the plain version (Ctrl-V), creating a new layer
- Add a Layer Mask to the top layer by clicking Layer->Add Layer Mask->Hide All

Luminance

- Click on the Layer Mask thumbnail to make it active
- Choose the Paintbrush tool and set the foreground color to White
- Paint on the screen where you want the deconvolved version to show through

Demo

Creating an LRGB

- Open the color image and flatten it (Layer->Flatten Image)
- Increase saturation using Match Color
- Open the luminance image and flatten it
- Select the entire luminance image (Ctrl-A) and copy to the clipboard
- Close the luminance image
- Paste onto the color image, creating a new layer
- Change the Blending Mode of the new layer to "Luminosity"

Adjusting the Luminance

- Sometimes the luminance layer can overpower the color and needs to be toned down
- With the luminance layer selected, create a Curves adjustment layer
- Click OK on the Curves dialog
- Hit Ctrl-G – this “clips” the Curves layer to the luminance layer just below it, so the adjustment applies only to that layer
- Re-open the Curves layer and make your changes, typically by pulling down on the middle of the curve

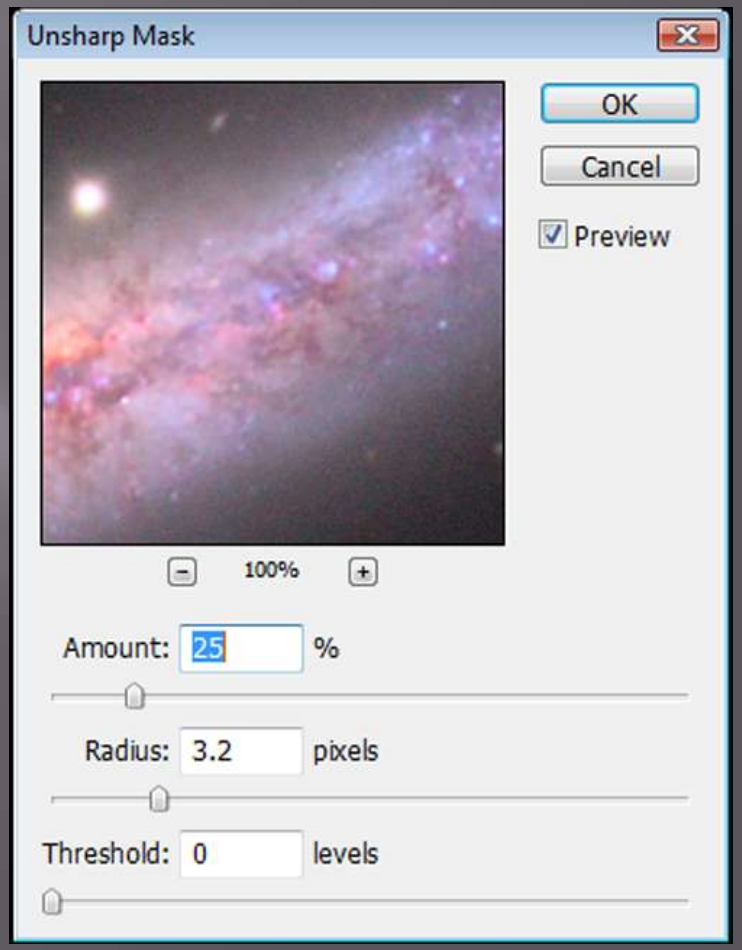
Demo

Sharpening

- I'll use either Unsharp Mask, High Pass or Focus Magic
- Start by creating a CAB layer
- We will apply the sharpening filter to the new layer, then add a layer mask to restrict the effect to the areas we want to sharpen

Unsharp Mask

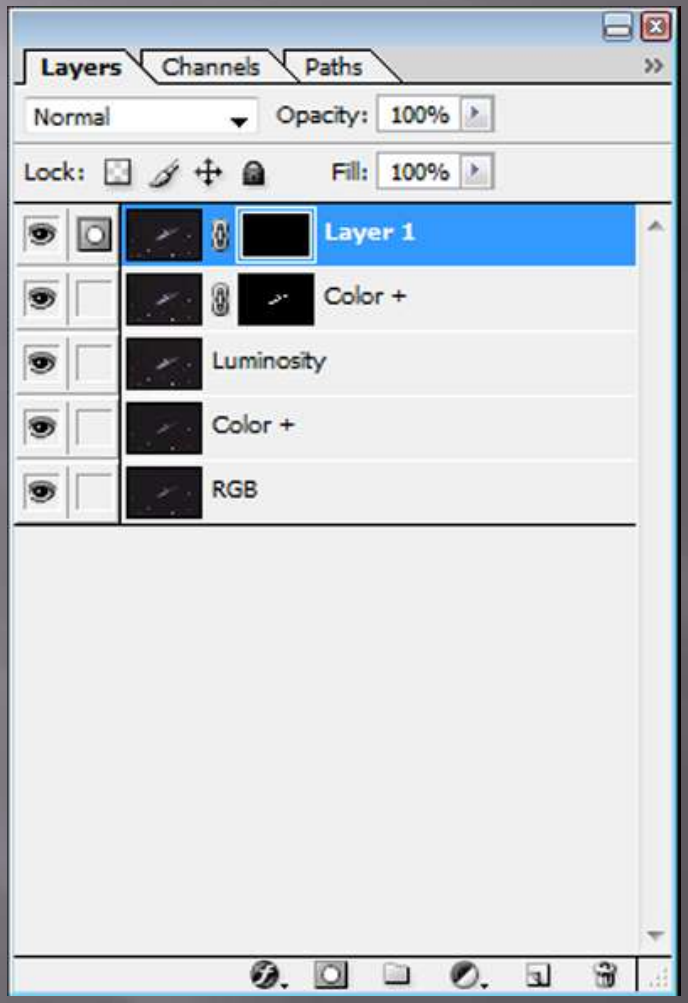
- Open the Unsharp Mask filter
- Set Amount low (20-25%)
- Set Radius according to what you want to sharpen
- Set Threshold to 0



Unsharp Mask

- Click OK to run the filter
- This has applied the filter to the entire image, which is likely not what we want
- Time for a layer mask!
- Click Layer->Add Layer Mask->Hide All
- Your sharpening effect will disappear, and a black layer mask thumbnail will show up on the sharpened layer

Unsharp Mask
Selective Sharpening



Unsharp Mask Selective Sharpening

- Click on the layer mask thumbnail
- Choose the Brush Tool
- Set the foreground color to white
- Set the brush size to something around the size of the structures you're working on
- If you're working on small structures, set hardness to 50% or more, otherwise set to 0
- Set mode to normal
- Set opacity and flow to 50-100%

Unsharp Mask
Selective Sharpening

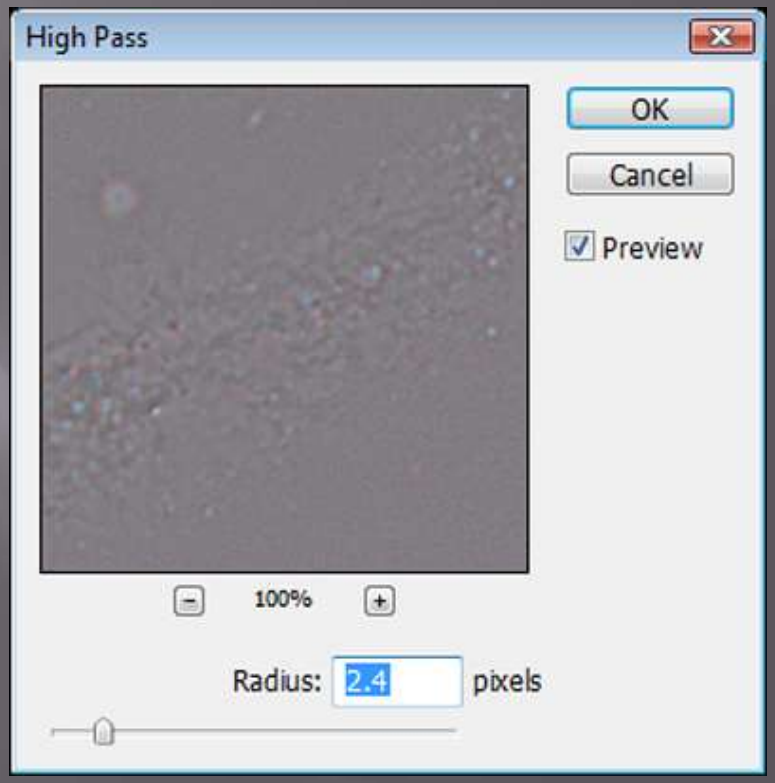
- Paint on the image in the places you want the sharpening to be visible
- If you accidentally affect a region you didn't want, change the foreground color to black and paint over that area
- Typically want to avoid the stars

Unsharp Mask

- Note that you can perform multiple passes with different radii to emphasize different structures in your image
- Done properly, this can give your image a 3-d effect
- You can increase the Unsharp Mask Amount to a higher value when working on bright areas that have a lot of fine detail

High Pass Filter

- Create a CAB layer
- Click Filter->Other->High Pass
- Image will turn gray
- Adjust the Radius until the structures you want to emphasize appear
- Click OK



High Pass Filter

- Change the blending mode of the High Pass layer to either Overlay (for a stronger effect) or Soft Light (for a weaker effect)
- Reduce the opacity of the layer to further reduce the effect if necessary
- As before, add a “Hide All” layer mask and paint where you want the filter to affect

Focus Magic

- A third party tool that sharpens by applying a deconvolution algorithm
- Also can help repair slightly trailed stars
- Looks like it will be a worthwhile tool to have in the bag
- So far I like its effect better than the Unsharp Mask or High Pass filters

Demo

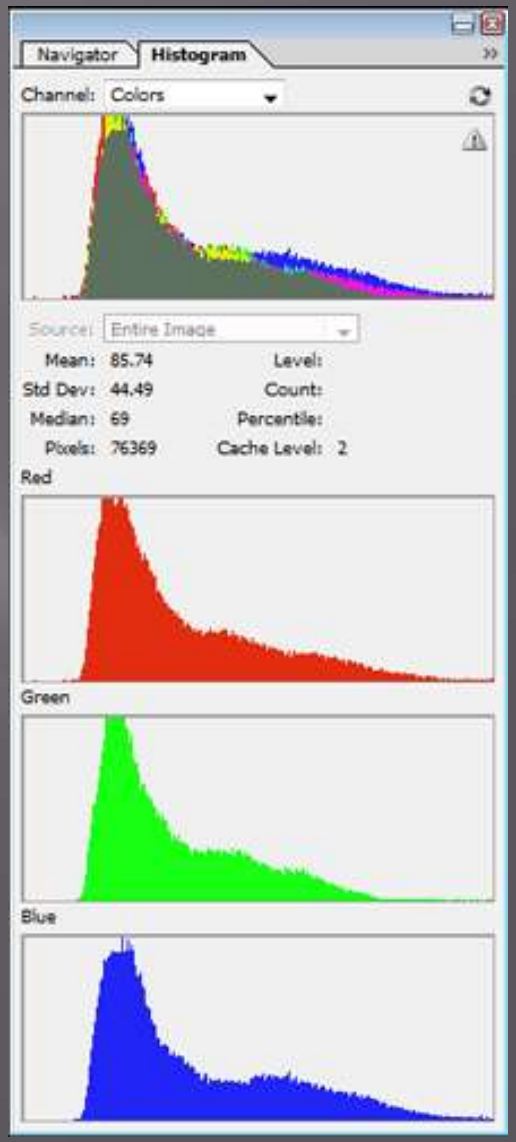
Other Topics

Galaxy Color

- Open to interpretation
- Depending on where you look in the sky, the amount of blue extinction caused by dust can vary a lot
- You can choose to leave the color "as is" (galaxy will look yellow/red), or you can try to "correct" for it
- The "yellow core/blue arm" look of most galaxy images is the result of fiddling, but it isn't as arbitrary as you might think

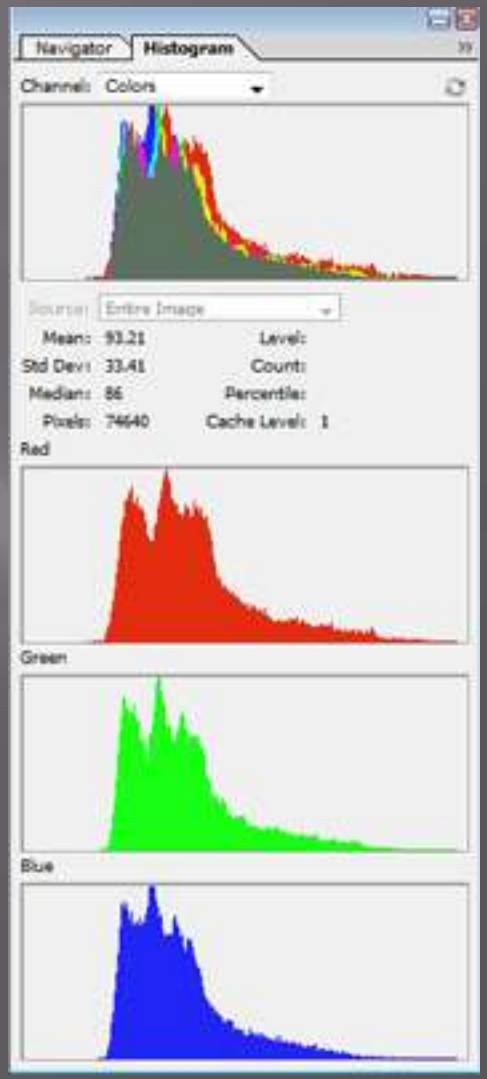
Galaxy Color

- An observation by Don Goldman and Chris Schur – the red, green and blue histograms of a galaxy image with no dust extinction are roughly equal



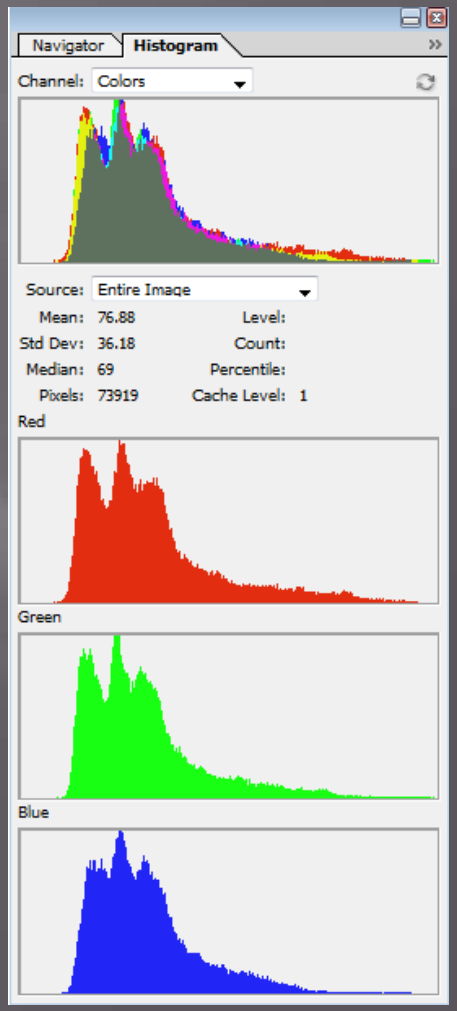
Galaxy Color

- A galaxy image taken through intervening dust will show the histogram skewed to the red



Galaxy Color

- With the galaxy selected, use Curves and Channel Mixer (to equalize the low point) to even out the histograms
- Curves adjustments typically involve cutting red and boosting blue
- Adjustments needed are usually pretty small



Galaxy Color

- This will start to bring out the blue arms and the pink H-II regions

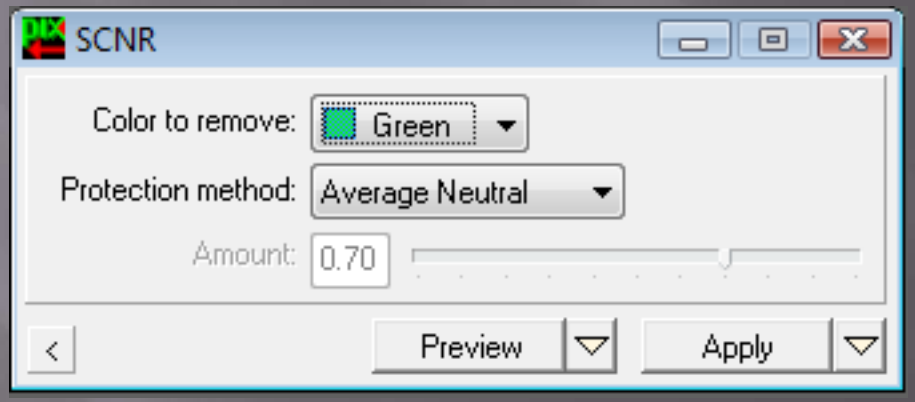
Demo

Green Noise

- A subtle problem that can plague CCD images is green pixel noise
- There's not much out there that's green!
- Quickest way to get rid of it is to use PixInsight
- The "LE" version is free, but may not be available any more

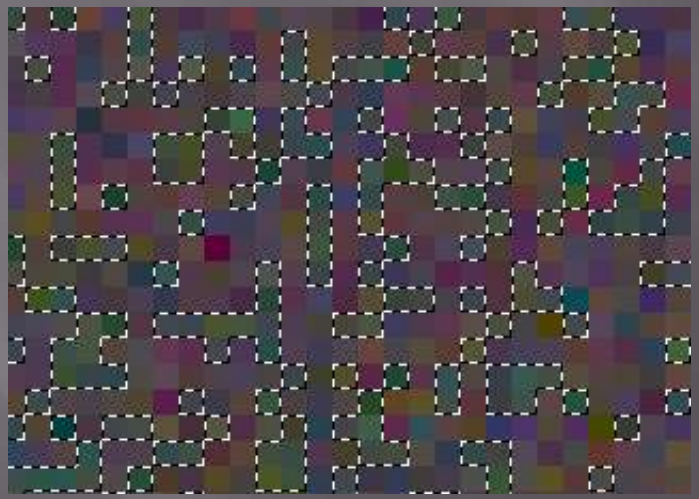
Green Noise - PixInsight

- Choose Process->General->SCNR
- Choose “green” and click apply
- That’s it!



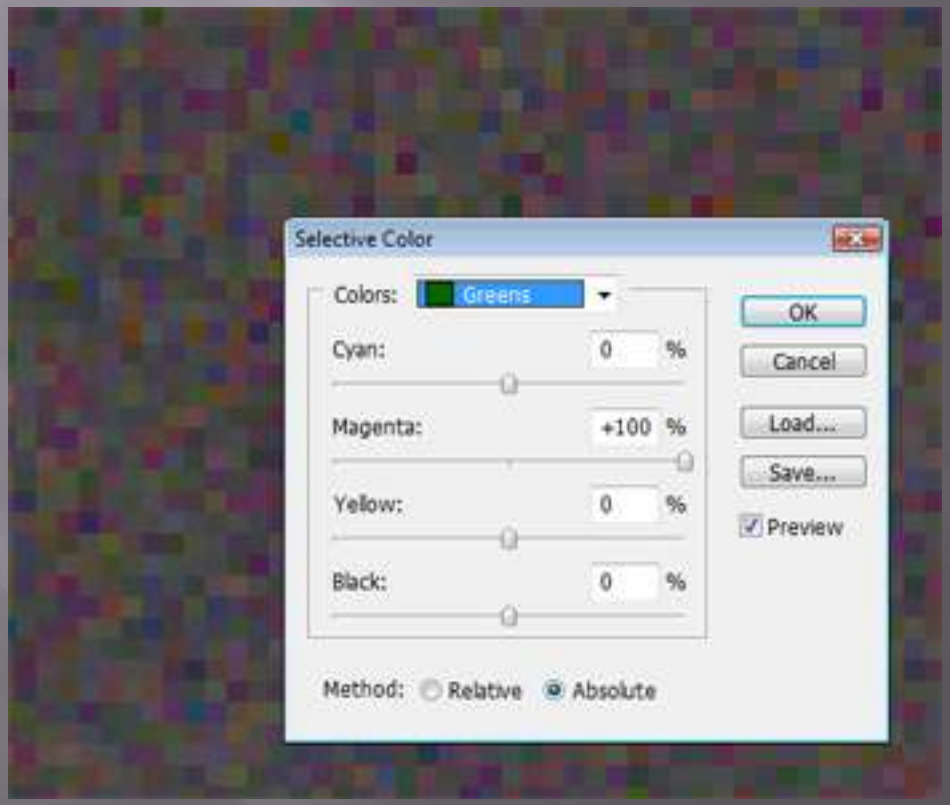
Green Noise - Photoshop

- To do the same thing (with more control) in Photoshop, use the Tony Hallas Green Pixel Gun
- Set the Eyedropper to a “point source” sample
- Use Select->Color Range to choose the green pixels
- Set fuzziness to around 40



Green Noise - Photoshop

- Use Selective Color to kill the greens by adding magenta



Green Noise - Photoshop

- You can also use Curves instead of Selective Color to make this adjustment
- Pull down the Green channel, then raise the RGB channel to compensate for the loss of brightness
- This technique takes some work, but it will get the job done

Shrinking Stars

- Minimum Filter
- Curves on individual stars

Minimum Filter

- Create a CAB layer (Ctrl-Alt-Shift N E)
- Select the stars (use Select->Color Range with high fuzziness or hit Ctrl-Alt-Shift ~)
- Deselect any non-stars that might have been picked up
- Click Select->Modify->Expand and choose 4-6 pixels
- Click Select->Feather and choose 2 pixels

Minimum Filter

- Choose Filter->Other->Minimum
- Set Radius to 1 pixel and click OK
- This will usually overdo it
- In the Layer palette, make sure the proper layer is selected and lower the Opacity to around 75%
- This will back off the effect of the Minimum filter and help minimize artifacts

Minimum Filter

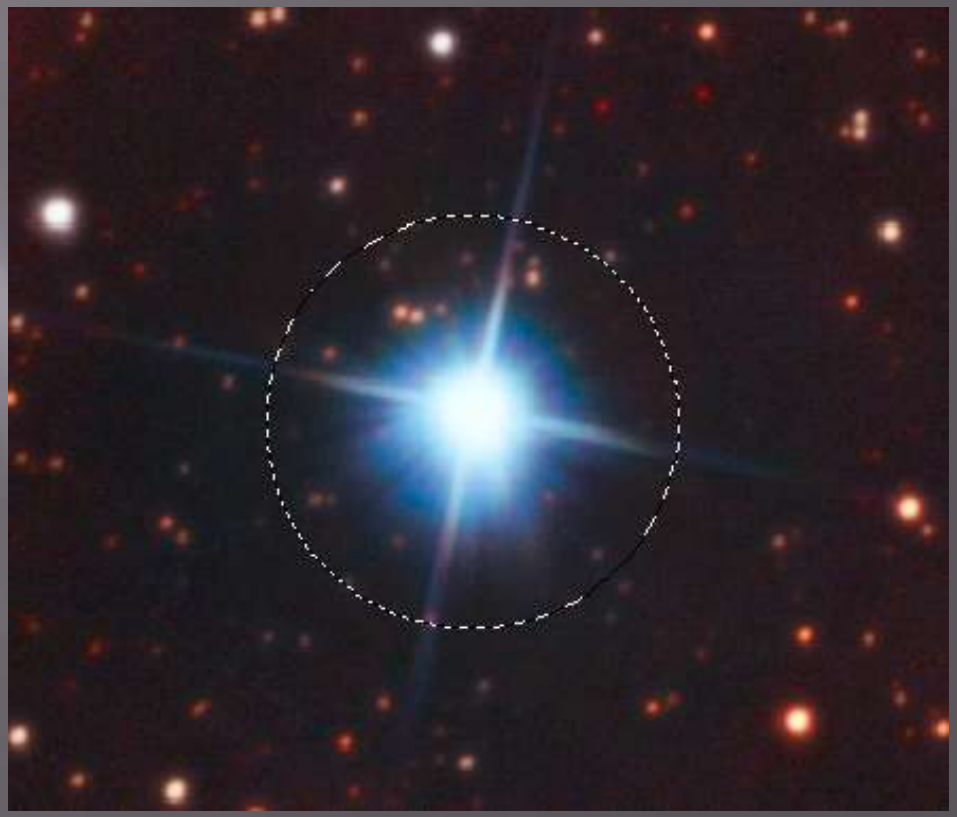
BEFORE

AFTER

Demo

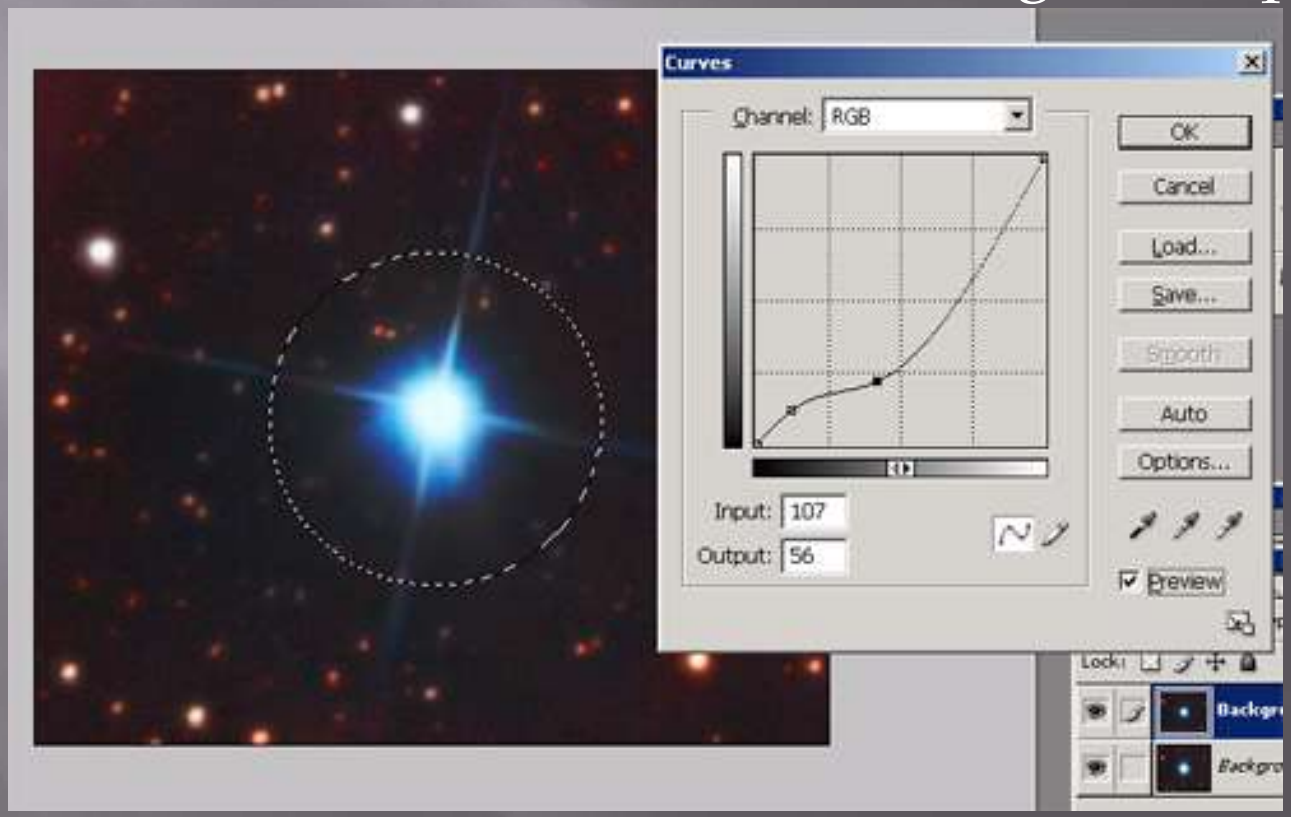
Shrinking Stars with Curves

- Must be done carefully on one star at a time
- Clearly good only for a few big "problem" stars
- Choose the Elliptical selection tool and set the feather to around 10 pixels
- Use the tool to select an area a little bigger than the star (i.e. include some sky)



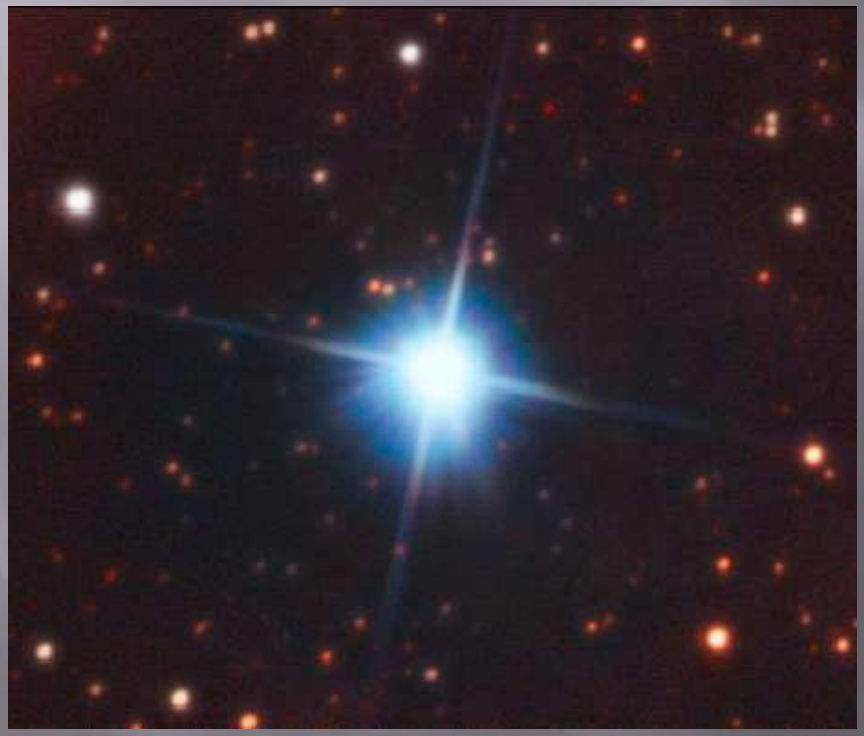
Shrinking Stars with Curves

- Ctrl-Click on the nearby sky background to place a point on the curve
- Pull down the curve above the background point



Shrinking Stars with Curves

BEFORE



AFTER

Demo

Disaster Recovery

- What happens if you try to shoot M81 with a quarter moon up?

Disaster Recovery

- Hitting it with Gradient XTerminator, PixInsight LE green noise reduction (each multiple times), and Noise Ninja got it to this point

Disaster Recovery

- After putting the LRGB together, increasing saturation, sharpening and adjusting contrast with levels and curves

Disaster Recovery

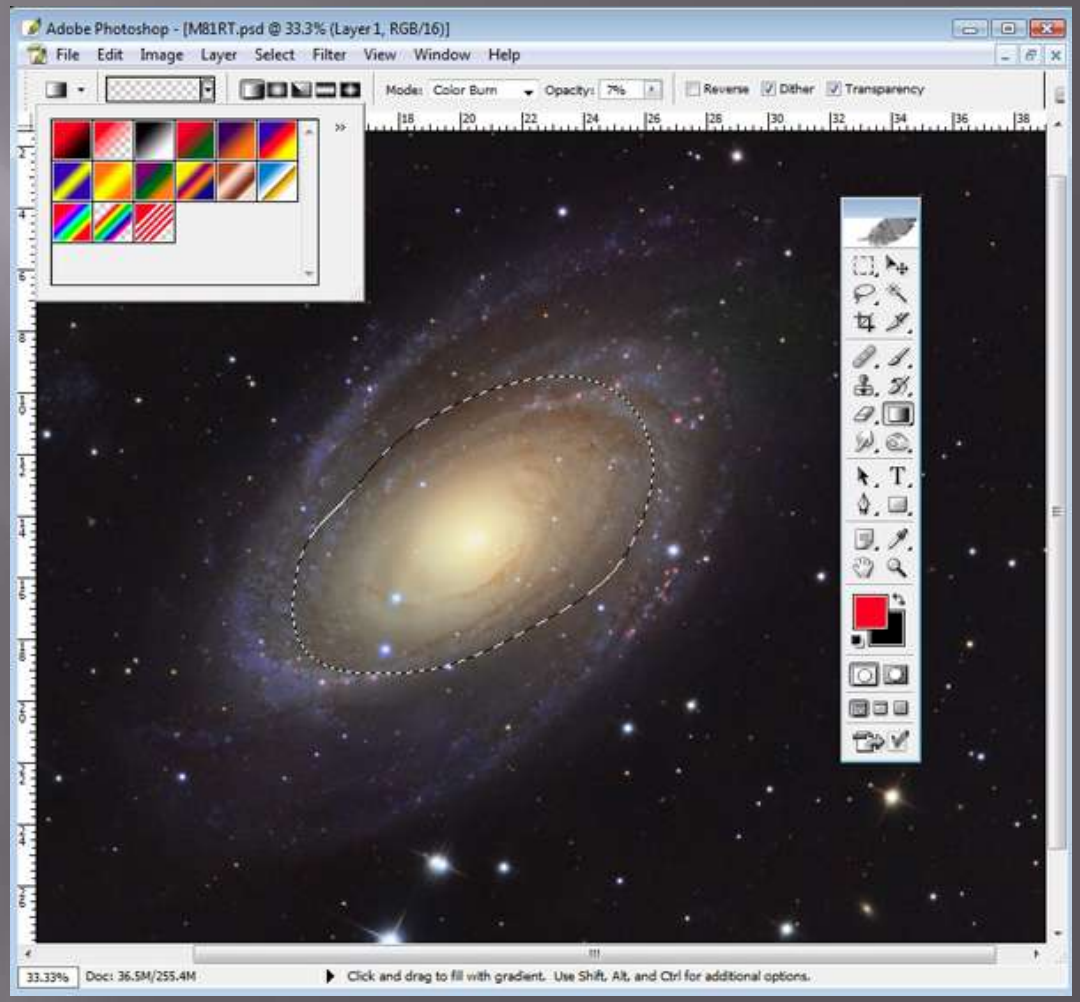
- Some Selective Color and Curves adjustments to the color channels plus a saturation increase gets us here

Disaster Recovery

- Finally, the core looked like it had a gradient from cyan to red running across it

Disaster Recovery

- I created a CAB layer, selected the core with the Lasso (55 pixel feather) and used the Gradient tool in “color burn” mode, with red as the foreground color
- Choose “Foreground to Transparent”



Disaster Recovery

- Draw a line from the cyan portion of the core to the red portion
- This will burn the cyan part with red (its opposite), eliminating the gradient
- Will probably take a bit of trial and error

Disaster Recovery

- Here's the end result – not great but not bad considering what I started with

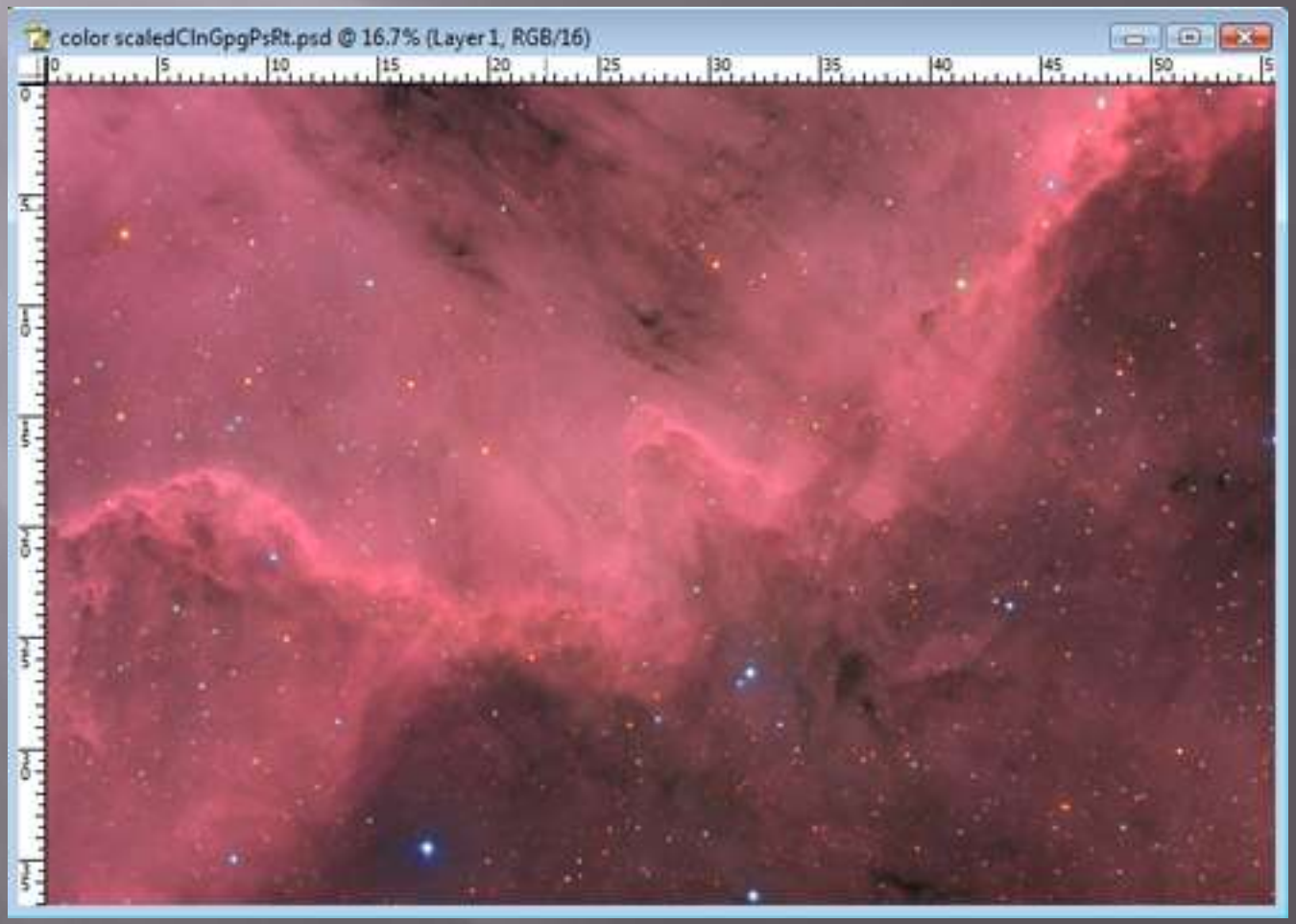
Demo

H-alpha Color Images

- Adding H-alpha filtered data to emission nebula images can increase detail and contrast
- Not an easy process
- First thought is to use H-alpha image as luminance with a normal RGB
- H-alpha filtered stars are a lot smaller than RGB stars, leaving holes around the stars
- H-alpha data tends to overpower your color data, turning reds and pinks into the dreaded *Salmon*

H-alpha Color Images

- Yuck!



H-alpha Color Images

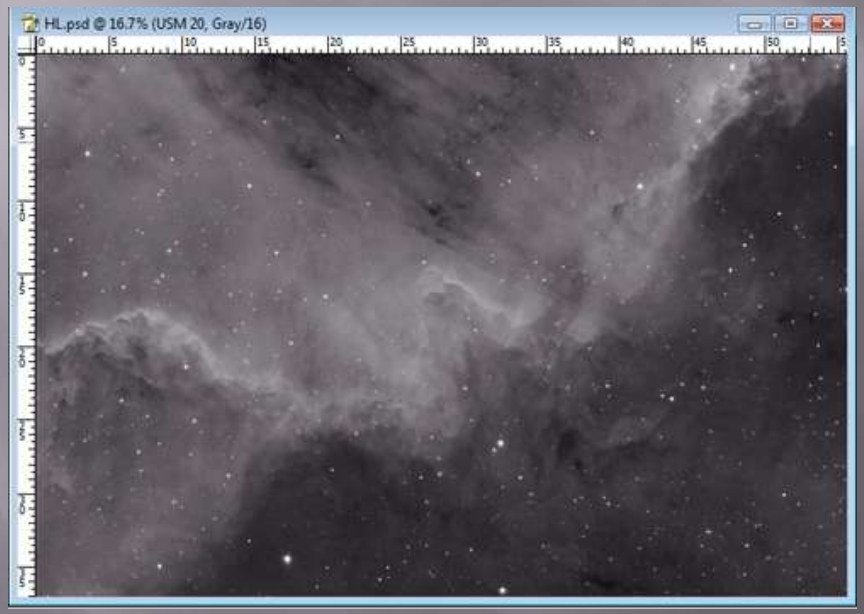
- Don’t use stars from the H-alpha data
- Tone down the H-alpha so that it doesn’t overpower the color

H-alpha Color Images Stars

- Take a set of Luminance frames in addition to the Ha and RGB (as if you were going to make a regular LRGB)
- Open the H-alpha and Luminance images in Photoshop
- Copy the Luminance image on top of the H-alpha image
- Change the blending mode of the Luminance layer to Lighten
- This should keep the H-alpha nebula detail and "turn on" the Luminance stars

H-alpha Color Images
Stars

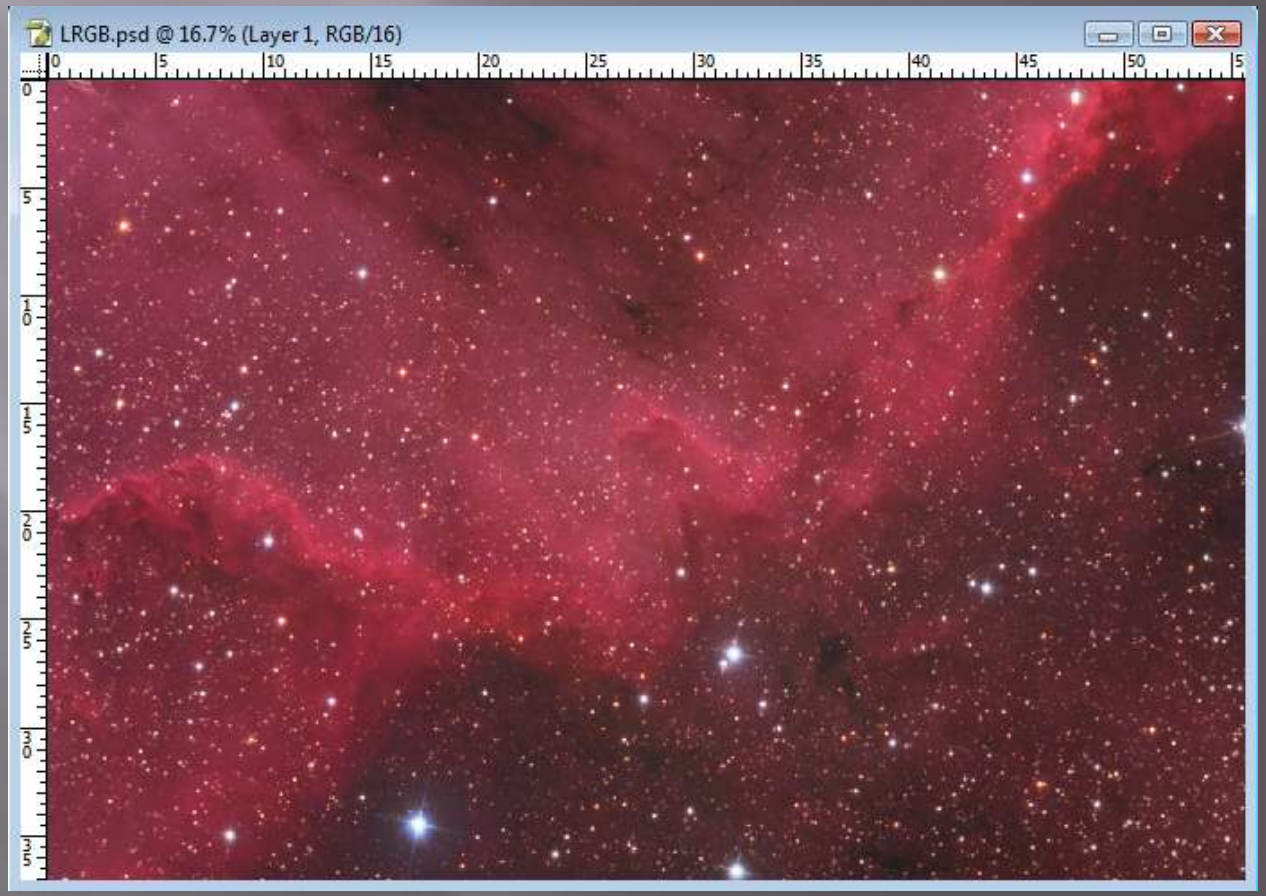
H-ALPHA ONLY



H-ALPHA + LUMINANCE

H-alpha Color Images

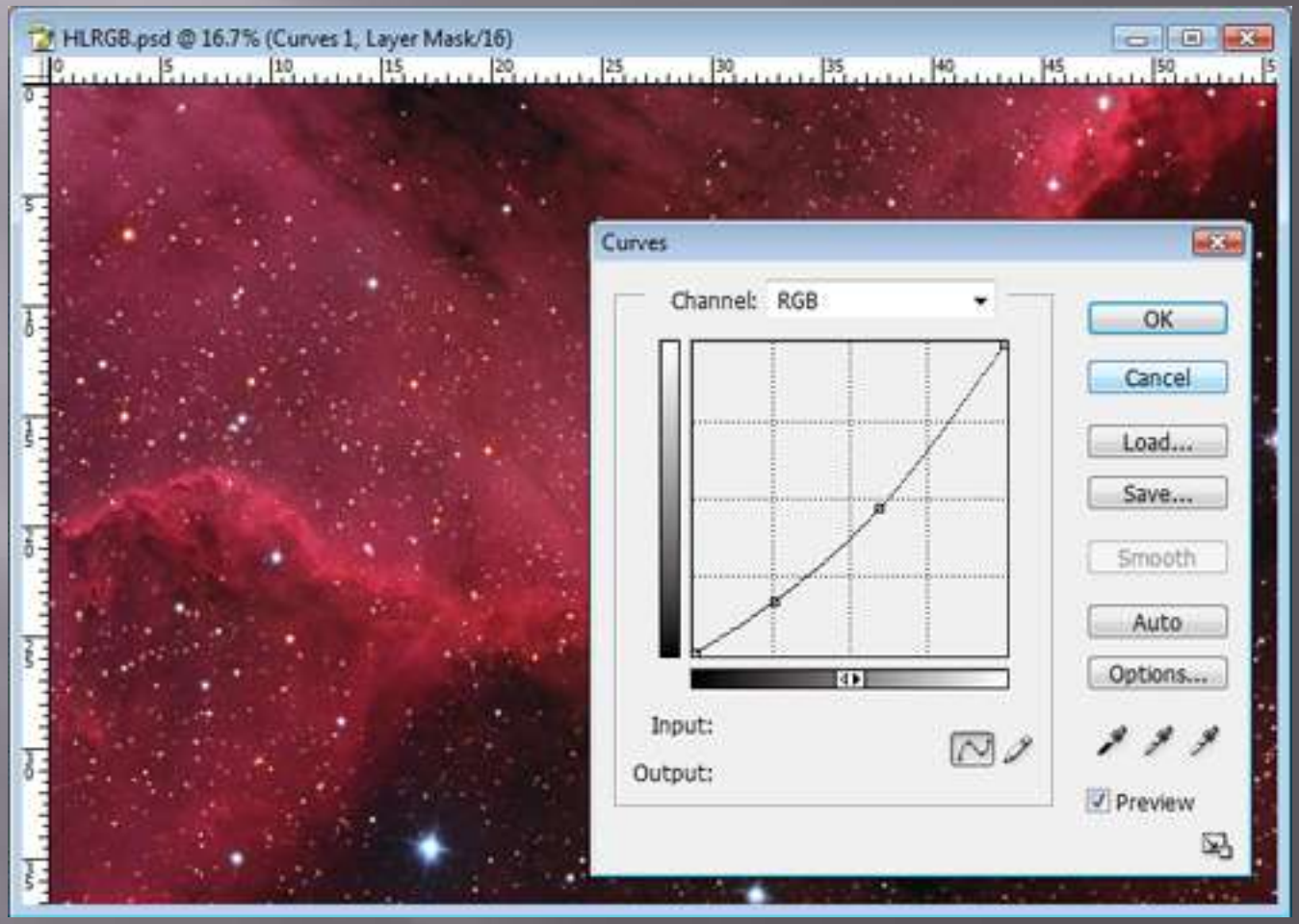
- Create a good LRGB image with strong, vibrant color



H-alpha Color Images

- Flatten your LRGB image
- Flatten your H-alpha/Luminance image and paste it on top of the LRGB
- Set the mode to Luminosity
- Create a Curves adjustment layer and click OK
- Hit Ctrl-G to clip it to the Ha/L Luminosity layer
- Open the Curves layer again and pull down the curve until the color again looks reasonable

H-alpha Color Images



H-alpha Color Images

- After some seasoning…

Demo

Galaxy HII Regions

- Some galaxies, such as M33, have a huge amount of HII regions in the arms
- You can add H-alpha filtered data to a traditional LRGB exposure to highlight these regions

Galaxy HII Regions

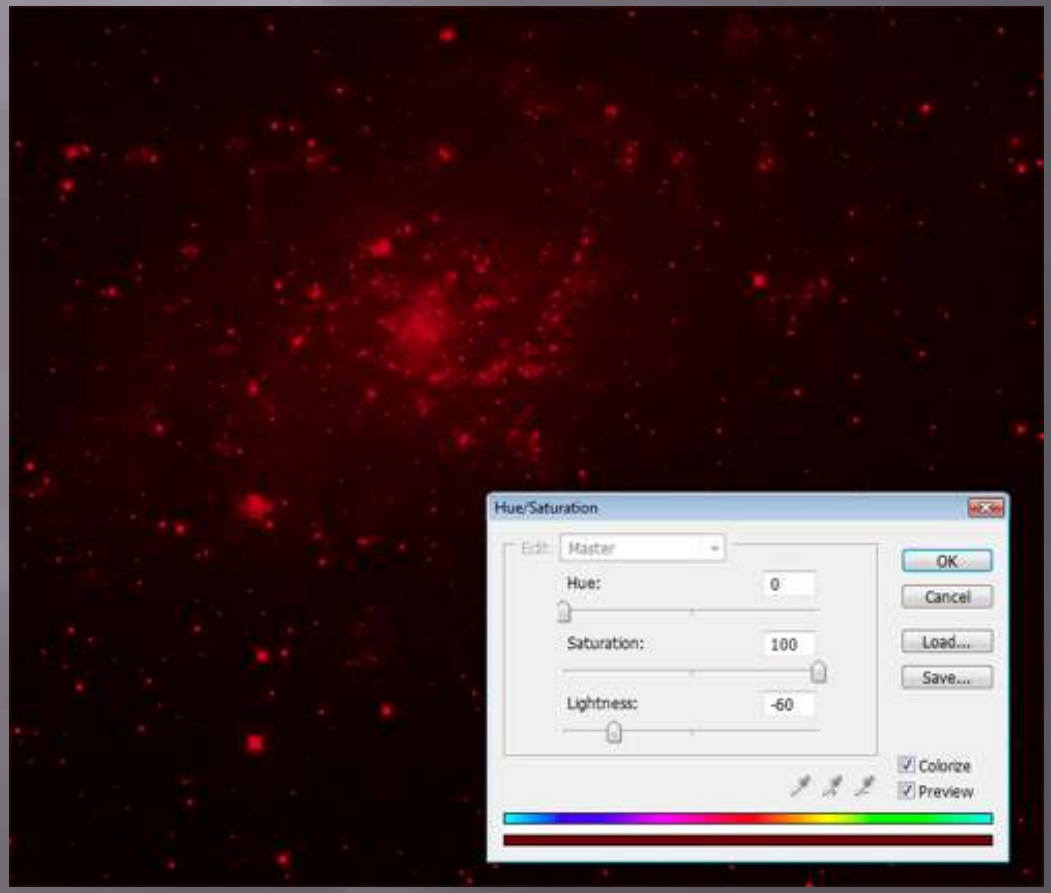
- Process your LRGB data as you normally would
- Colorize your H-alpha data using Clipping Masks

Galaxy HII Regions

- Processed grayscale H-alpha image

Galaxy HII Regions

- Use a Hue/Saturation Adjustment Layer to color it red

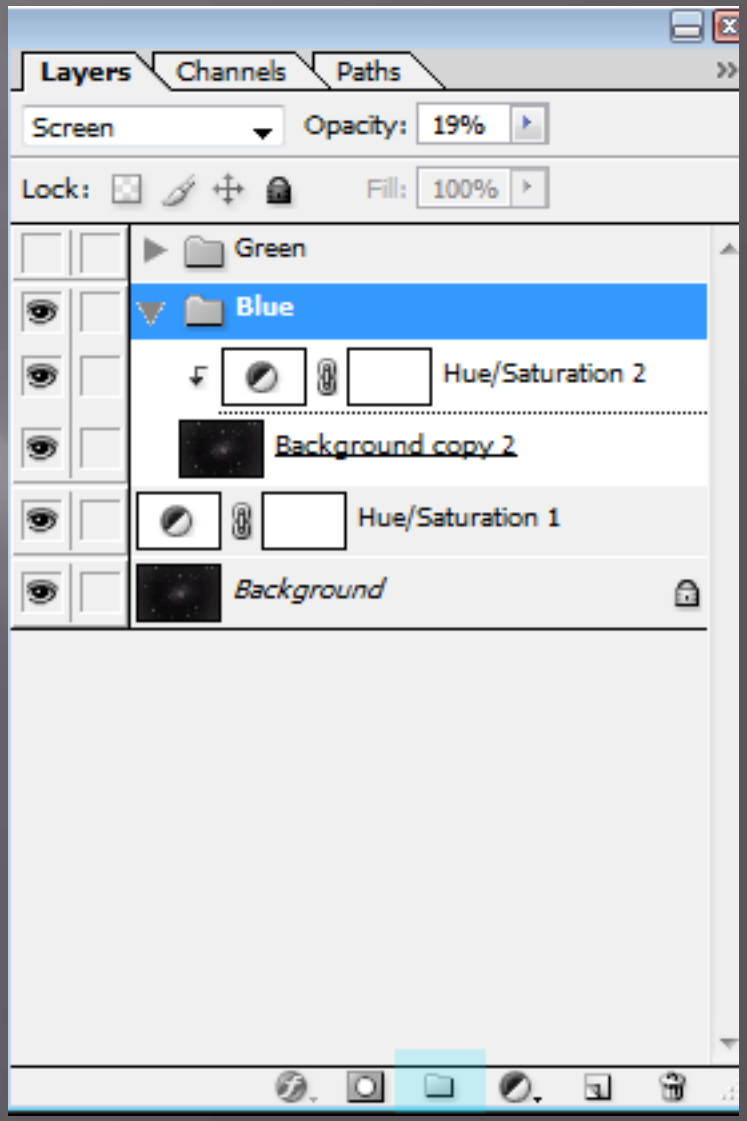


Galaxy HII Regions

- Hydrogen emission isn't pure red, it's pink
- Need to add some blue and even a little green
- Create a copy of your background layer
- Add a Hue/Saturation Adjustment layer and "clip" it to the background layer copy by hitting Ctrl-G
- Use the Hue/Saturation layer to colorize the background copy blue

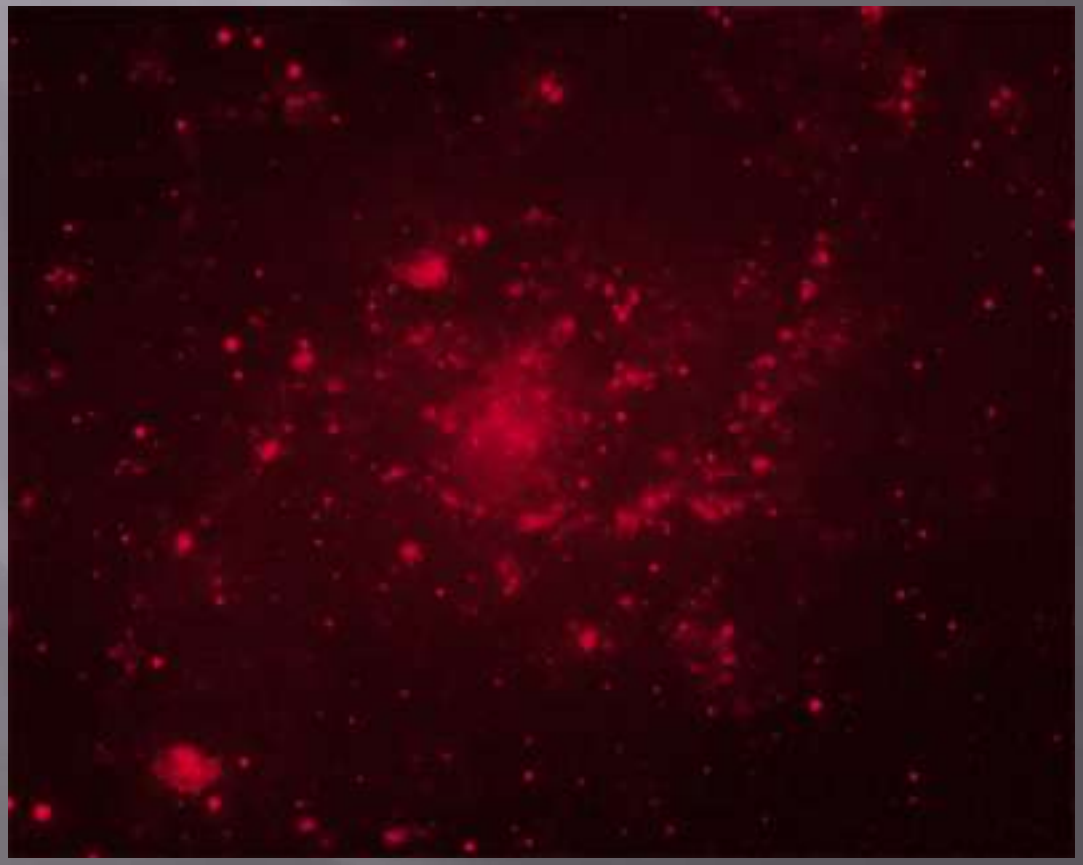
Galaxy HII Regions

- Create a Layer Set and drag the two new layers into it
- Choose the layer set, change mode to Screen and opacity to between 15 and 20%
- Do the same to create a green layer set, setting opacity to between 5 and 10%



Galaxy HII Regions

- You now have a colorized H-alpha image



Galaxy HII Regions

- Copy your colorized H-alpha image to the clipboard (Ctrl-A Ctrl-C)
- Paste it onto your LRGB image, creating a new layer
- Set the mode of the H-alpha layer to Screen
- Add a “Hide All” layer mask
- Carefully paint onto the layer mask where you want the H-alpha to show through
- Use opacity of 50% on the paintbrush tool

Galaxy HII Regions

BEFORE

AFTER

Demo

Layering Multi-Length Exposures in CCDStack

- Some objects have such a huge dynamic range that you have to combine short and long exposures to reveal faint detail without blowing out the bright parts
- M42 is the classic example – the most famous object in the sky and one of the hardest to photograph
- This technique comes from Adam Block and appears on his instructional DVD set

Layering Multi-Length Exposures in CCDStack

LONG EXPOSURE

SHORT EXPOSURE

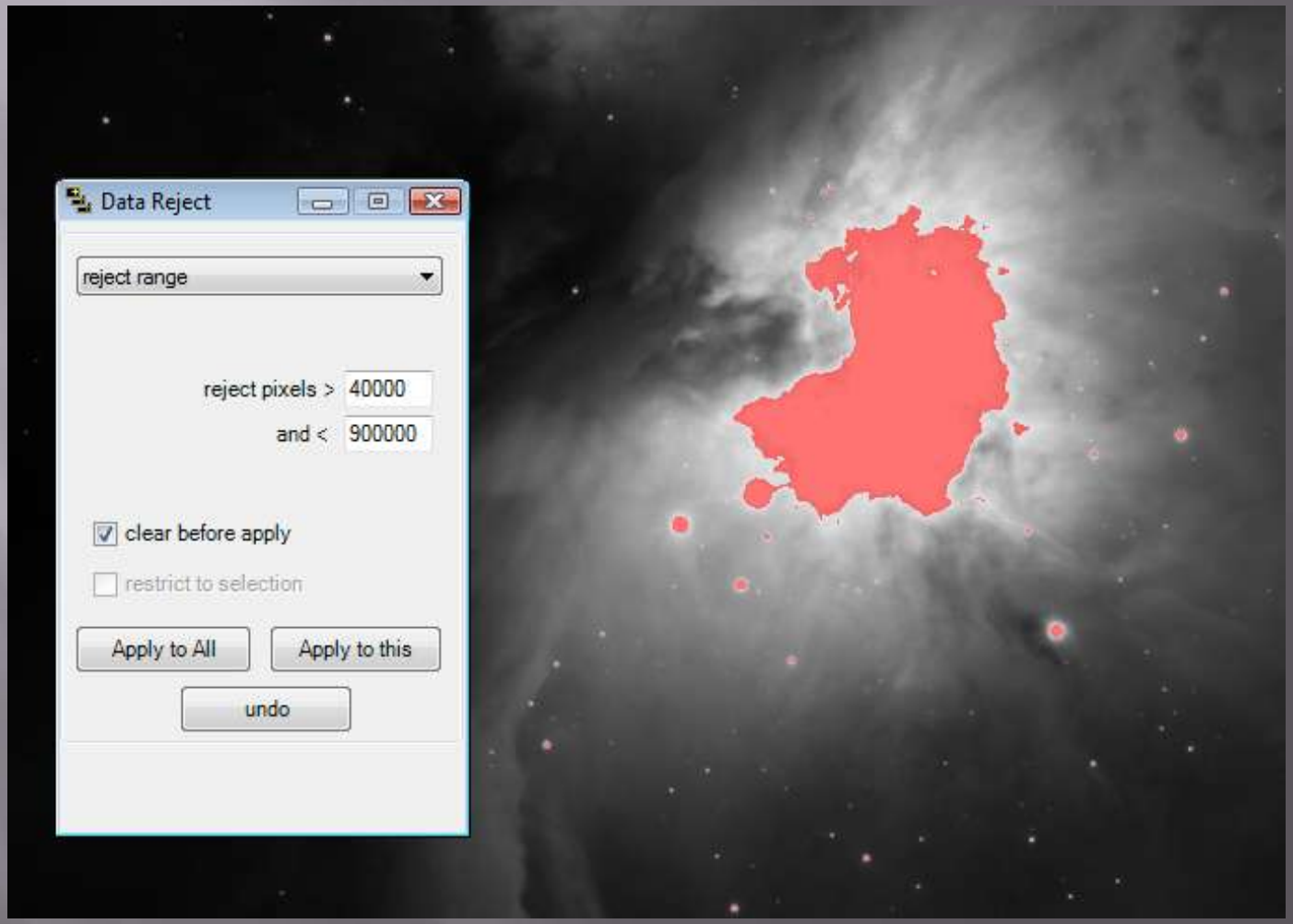
Layering Multi-Length Exposures in CCDStack

- To shoot M42 I took a series of 15-minute exposures and 30-second exposures
- Process each series into a mean-combined master FITS file
- Open each file in CCDstack
- Make the long exposure the active image
- Normalize them using “manual”, “both”
- Choose approximately the same regions in the two images, making sure not to select any saturated areas

Layering Multi-Length Exposures in CCDStack

- The normalization process will boost the short exposure to match the intensity of the long exposure
- While still in the long exposure, choose Data Reject->Reject Range
- In this case I set the values to be 40,000 and 900,000
- Click "Apply to This"
- This will pick up the core of M42 nicely, plus any blown out stars

Layering Multi-Length Exposures in CCDStack

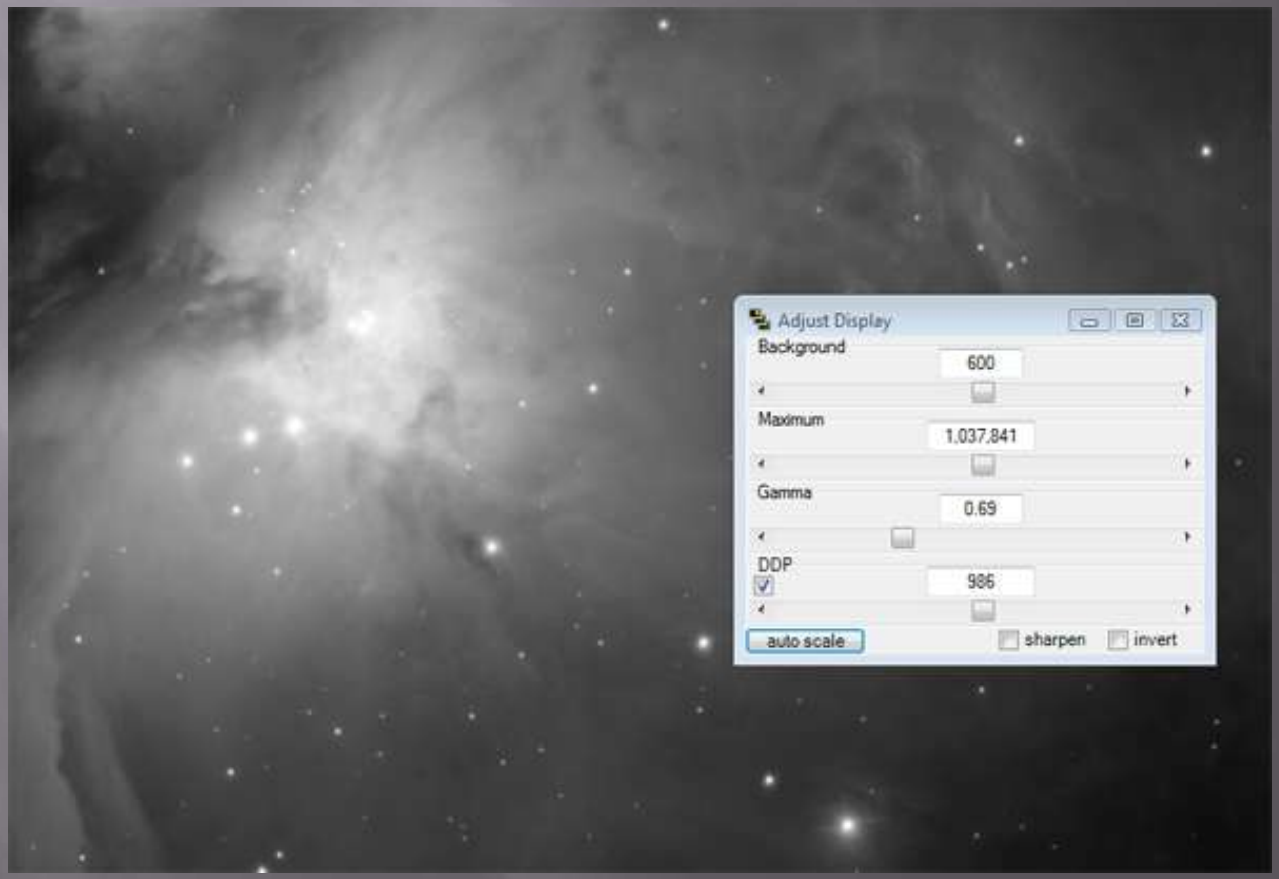


Layering Multi-Length Exposures in CCDStack

- Choose Data Reject->Grow and enter a value of 6 pixels
- Choose “Set Rejects to Missing Value”
- In the Image Manager, change the weight of the short exposure to .00001
- Choose Combine->Mean

Layering Multi-Length Exposures in CCDStack

- The end result is a seamless blend of the two images



Layering Multi-Length Exposures in CCDStack

- After performing the same procedure on the color and also blending a set of 60-second H-alpha exposures into the luminance, I ended up with this…

Layering Multi-Length Exposures in CCDstack

Demo

Preparing for the Web

- Flatten the image
- Resize the image
- Convert the image to sRGB color space
- Image->Mode->Convert to Profile
- Convert image to 8-bit
- Save as JPEG

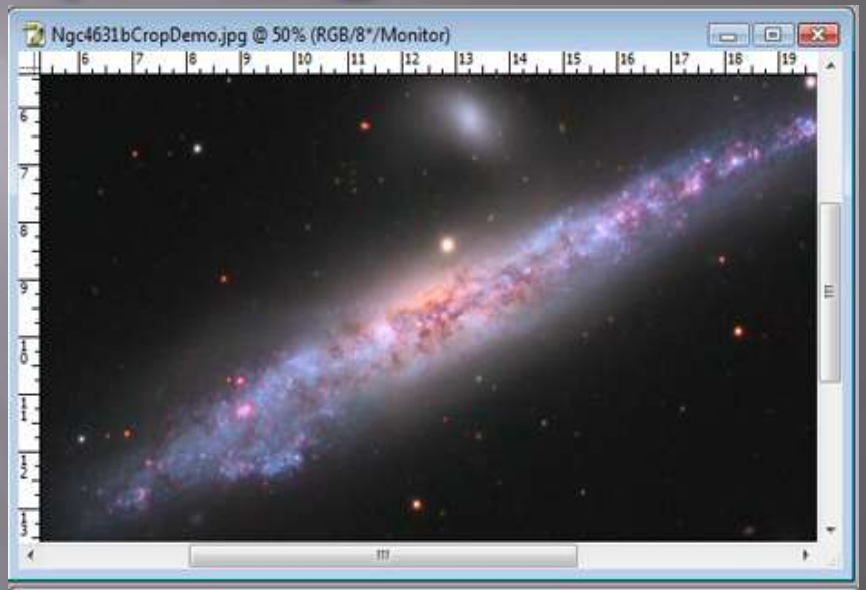
Preparing for the Web

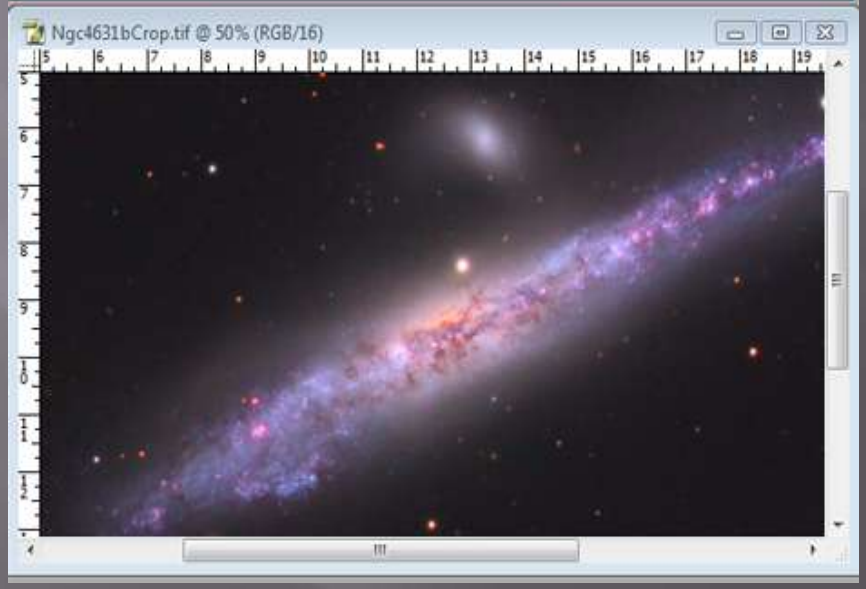
- If you open your JPEG in a web browser it will look very different from how it looked in Photoshop
- Web browsers do not have any color management!
- You have to adjust the JPEG so that it displays properly in the non-color managed browser

Preparing for the Web

- Open both the final version of your image and the JPEG version
- Tile the display so you can see both at the same time
- Make the JPEG the active image
- Click View->Proof Setup->Monitor RGB
- The JPEG will now look very close to what it looks like in the browser – lousy!

Preparing for the Web





Preparing for the Web

- Adjust the JPEG version to match the original
- I usually have to remove green, lower the contrast and brighten the background
- Save the adjusted JPEG
- It should look much more like the original when you view it in a browser

Demo

Resources

- Ken Crawford's tutorials – www.imagingdeepsky.com
- Adam Block's instructional DVD series – www.caelumobservatory.com
- Rob Gendler's tutorials and articles – www.robgendlerastropics.com
- Steve Cannistra's articles – www.starrywonders.com
- *Photoshop Astronomy* by Scott Ireland

Contact Info

- Web site: www.feraphotography.com
- Email: bob@zis.com
- Presentation is available at www.feraphotography.com/RTMC09.pdf

Reminder

- This is not a competition
- Don't be afraid to post your images to mailing lists – people will help!
- Your images don't have to be "better than _____'s"
- Have fun!

Thank You and Clear Skies!