

***Narrowband Filters
and
Image Processing***

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Topics

- What is Narrowband Imaging?
- Narrowband Filters
- Benefits
- Mapped Color Processing Tutorial



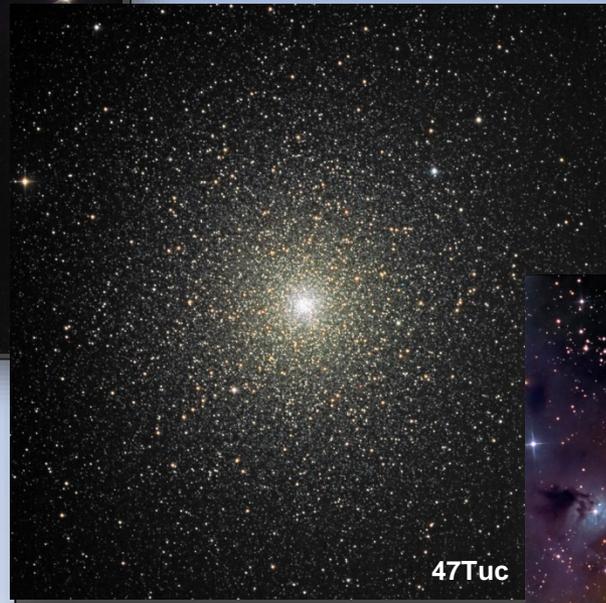
M1

Broadband Objects



NGC253

Galaxies



47Tuc

Star Clusters



NGC1579

Reflection Nebulae

Emit light over a continuum of wavelengths

Narrowband Objects



NGC7822

Emission
Nebulae



Helix

Planetary,
Wolf-Rayet
Nebulae

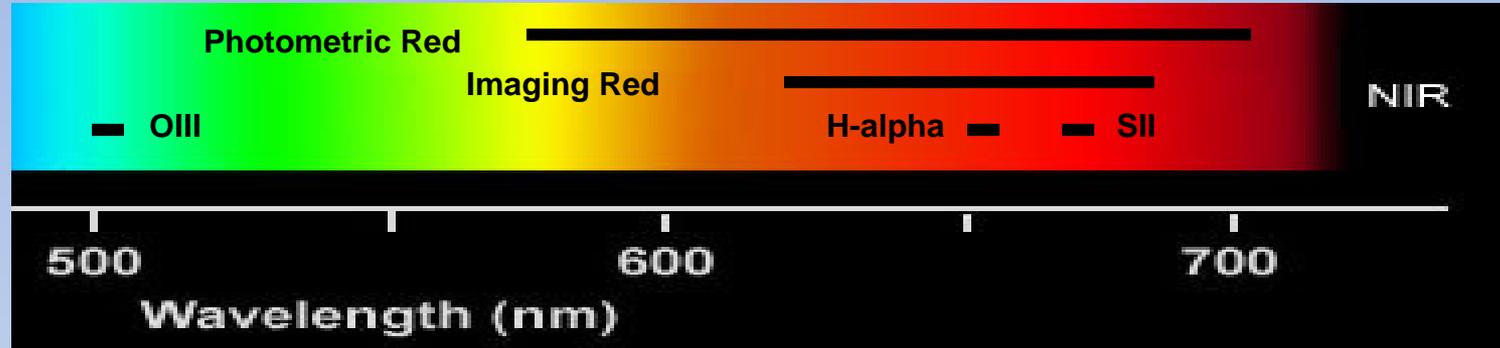


Vela

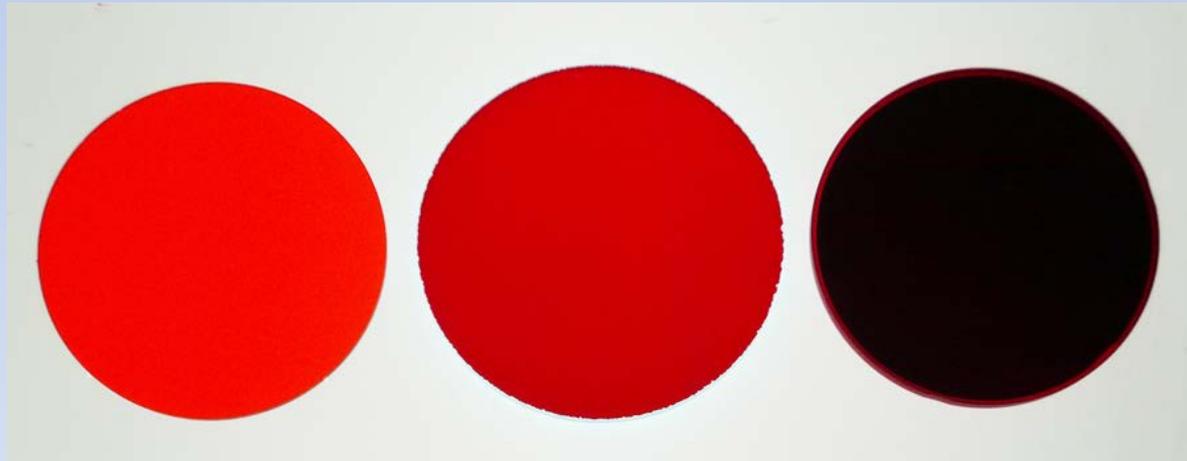
Supernova
Remnants

Emit light at discrete wavelengths due
to ionization from nearby UV stars

What is Narrowband?



Bandwidth
120 nm
80 nm
5 nm



Photometric Red
(UVB**R**I)

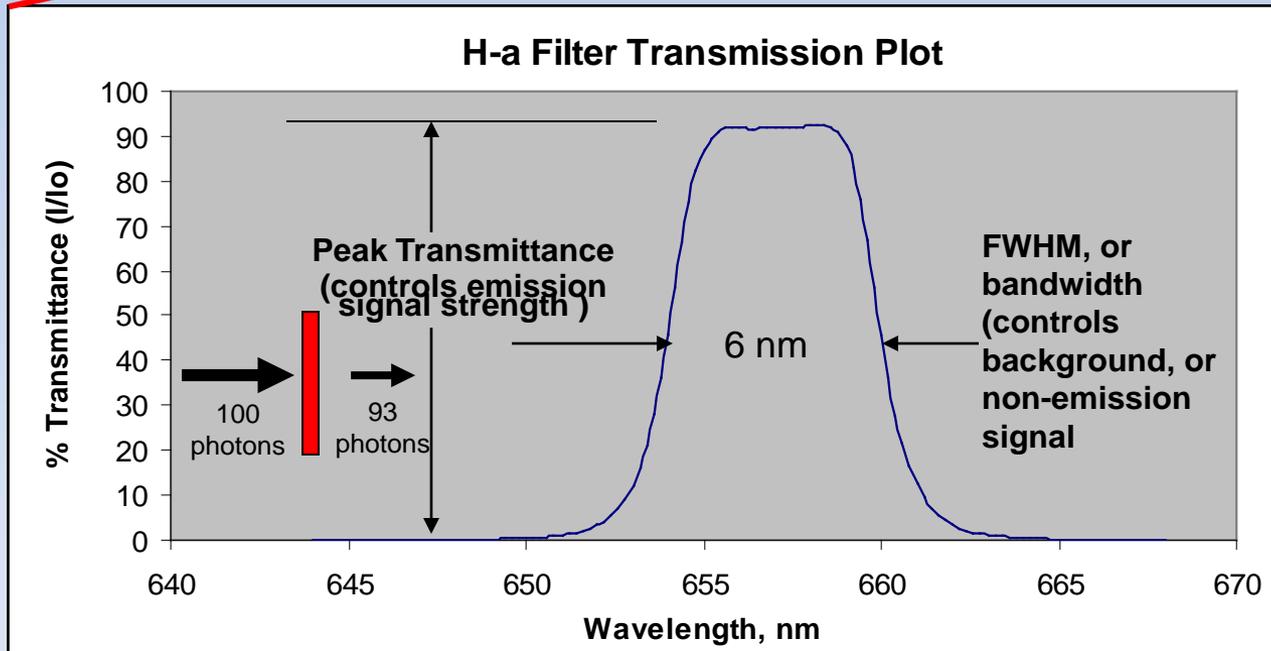
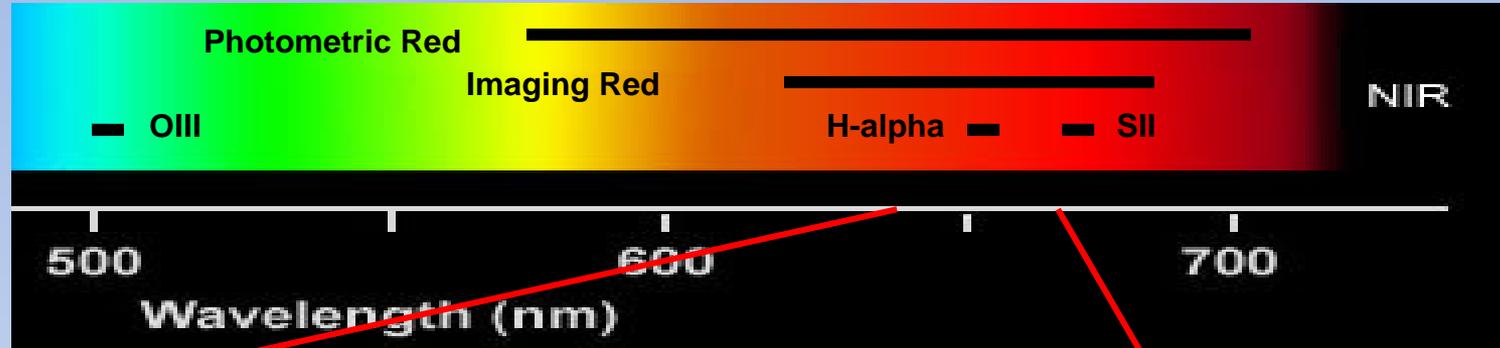
Imaging Red
(**R**GB)

H-alpha



H-alpha

Narrowband Filter

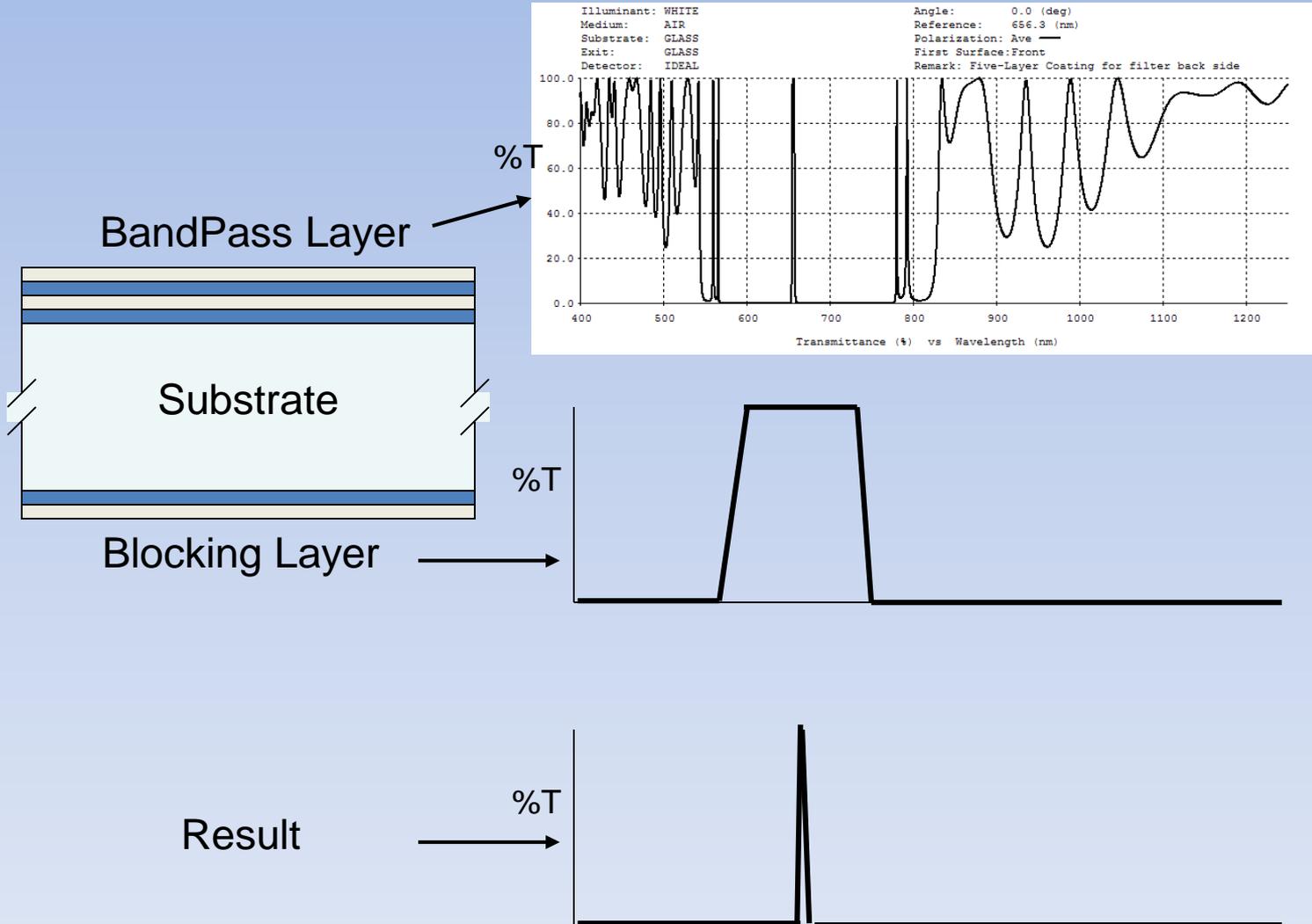


For highest contrast:

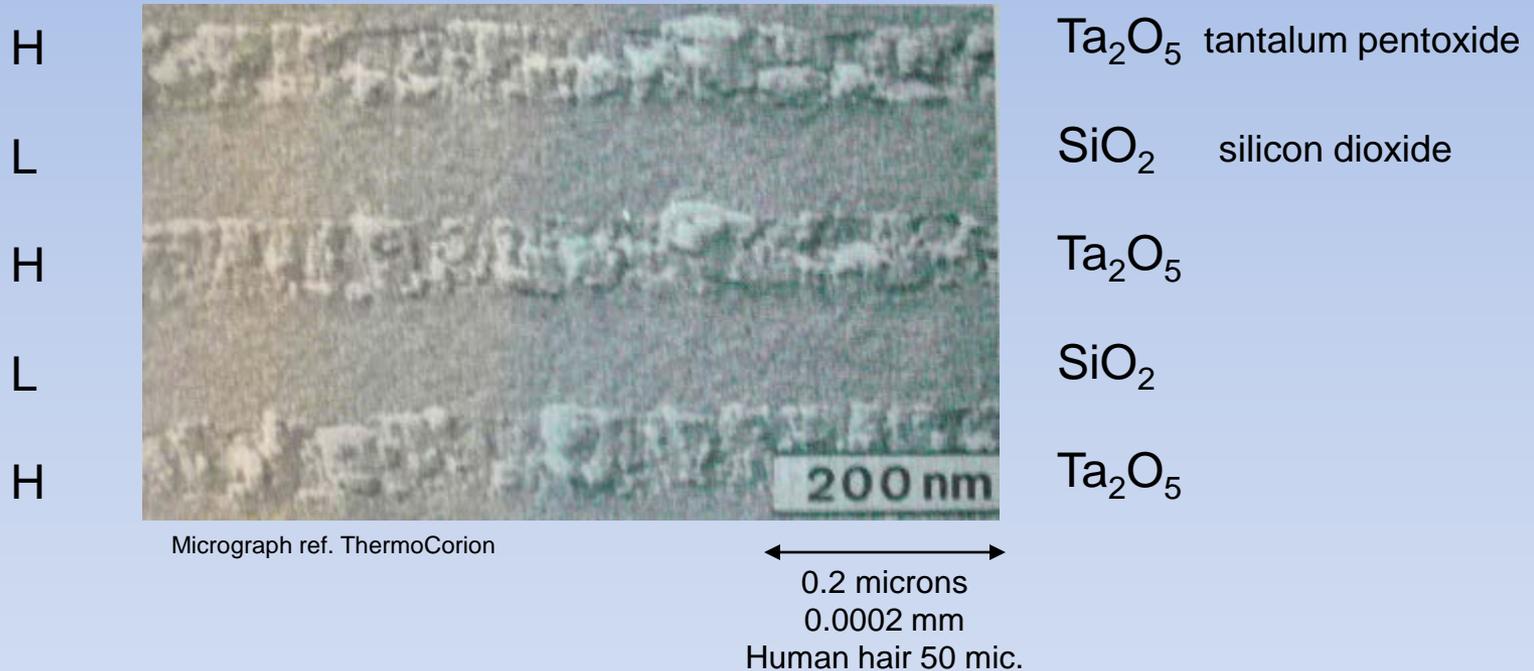
1. Highest transmittance
2. Smallest bandwidth

Background ADU count scales with FWHM

How NB Filters Are Made



Close-Up of Narrowband Filter



H = High refractive index layer (e.g., 2.3)

L = Low refractive index layer (e.g., 1.45)

N_e = effective index of layer = $\sqrt{H * L} = 1.8$ (affects blue shift)

Benefits of NB Imaging



Enhance contrast



Emphasize different structures H-a, OIII, SII

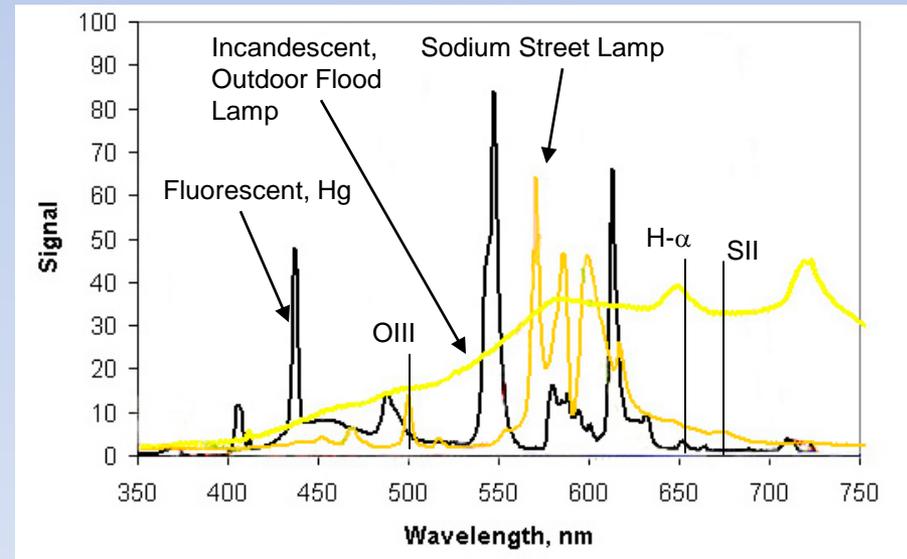
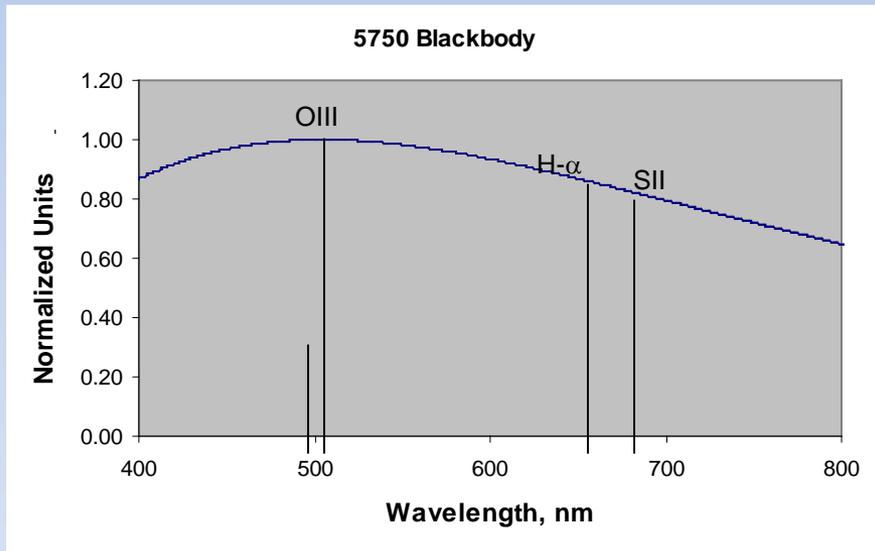
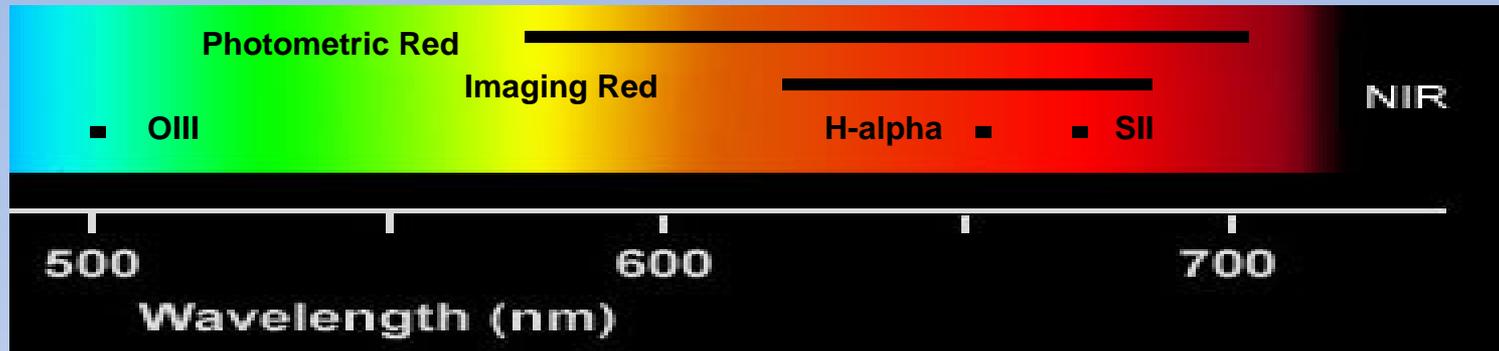


Use in light polluted areas



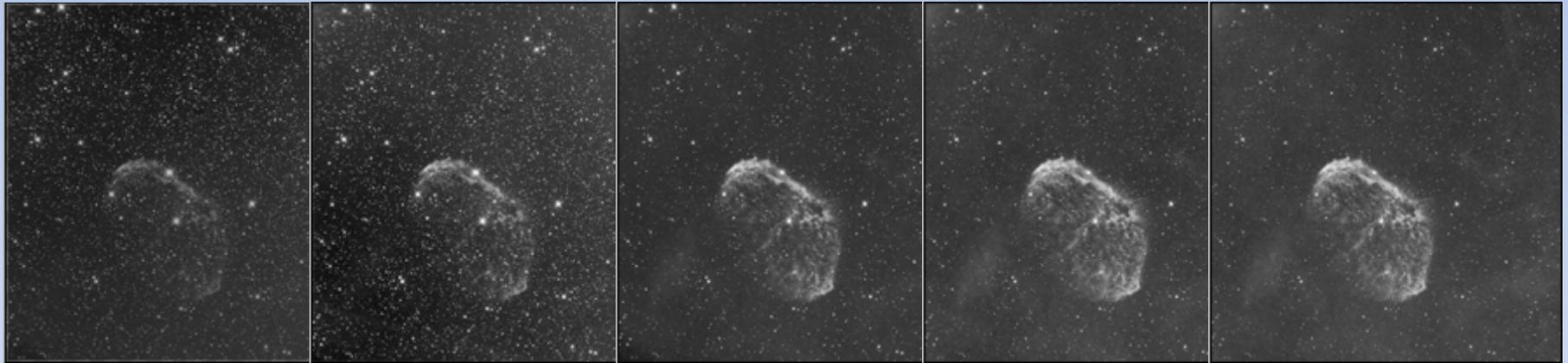
Extend imaging time when the moon is up

Moonlight & Light Pollution



Contrast Improvement

Crescent Nebula, Wolf-Rayet
Bubble in Cygnus, NGC 6888



Wide Red
(Orange)

Narrow Red

H- α 9 nm

H- α 6 nm

H- α 4 nm

3x5min exposures, RCOS 12.5" Ritchey-Crétien, SBIG
STL11000XM CCD, Bisque Paramount ME

Enhanced Structure at Hi-Res

Crescent Nebula in Cygnus, NGC 6888

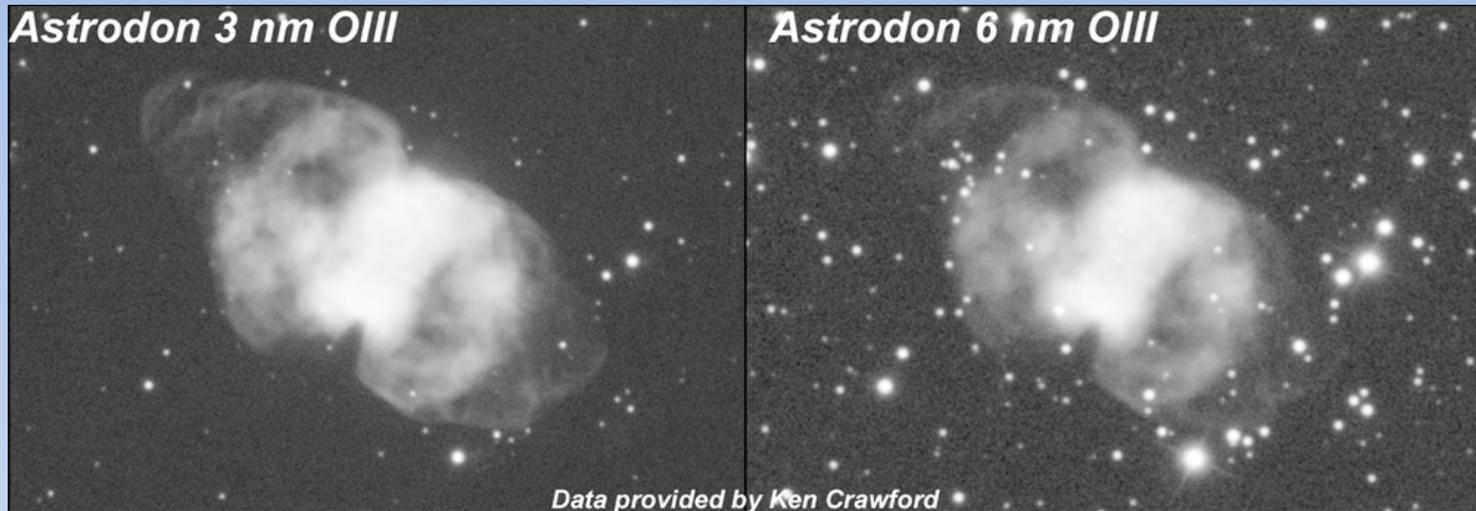


Conventional RGB
(courtesy Rob Gendler)



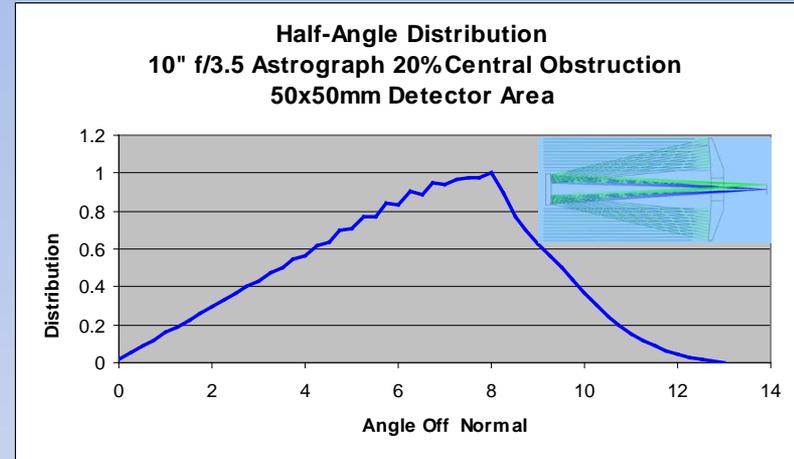
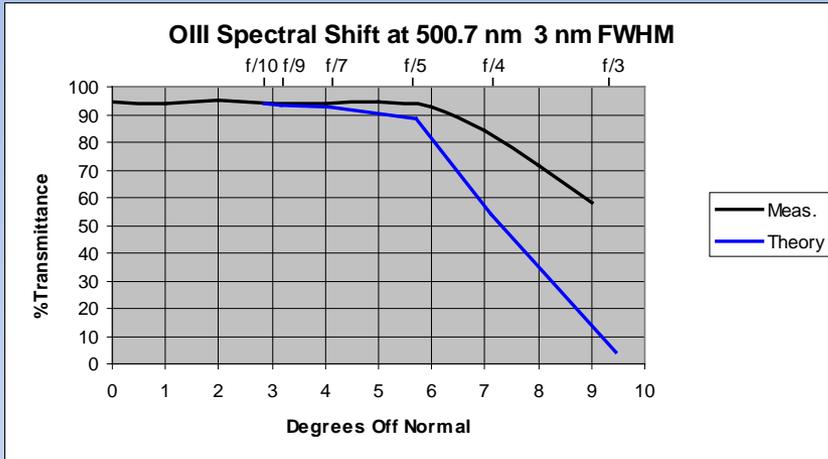
Red = H- α
Blue=Green=OIII
(Don Goldman)

Comparison of 3 vs 6 nm OIII



- 20" RC
- Full Moon
- Background ADU decreased from 5,700 to 1,800
- Gradient gone
- Smaller stars
- Greater faint detail
- Moonlight strongest at OIII

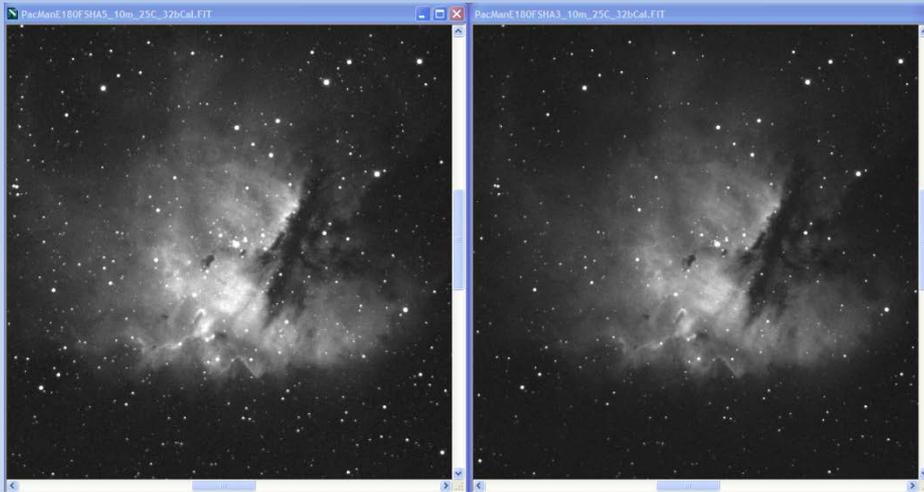
Fast Optics - Theory & Experiment



- Measurements show less %T loss than theory
- Telescope optics further reduces %T loss
- Loss ~ 10-15% for 3 nm NB filter at f/3.5 (92% to 80%T)
- Can use narrower filters for more systems
- May not have to buy separate filters for multiple scopes

H-a Comparison Fast Optics

Epsilon-180 at f/3



5nm FWHM >92%T

3nm FWHM > 92%T

SBIG STL11000XM, -25C, 10 min unbinned exposure, calibrated (dark, flat, bias), equalize screen stretch in MaximDL, Takahashi Epsilon-180 at f/3

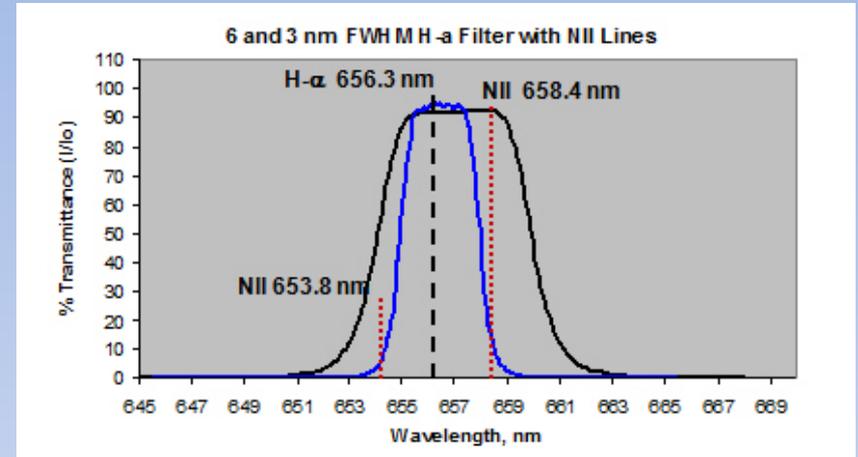
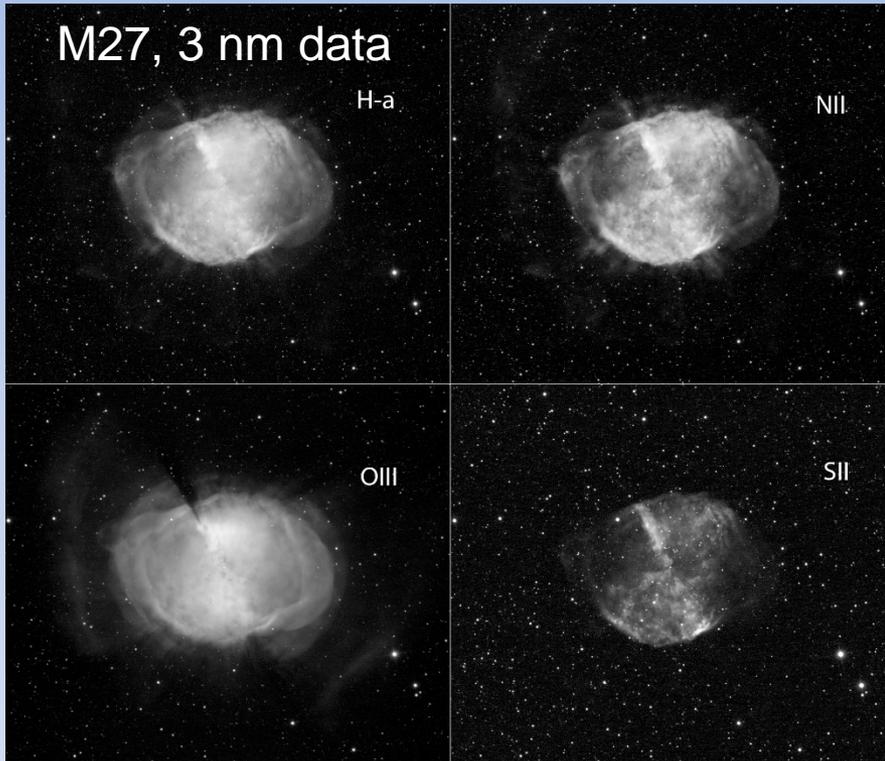
HyperStar on C14, f/2



3nm H-a FWHM > 92%T

20-minute uncalibrated exposure, QSI583, C14 with Hyperstar at f/2 from Gary Gonella

The Nitrogen (NII) Issue



- Wider H-a filters (>4 nm) contain H-a + NII
- Pros will refer to this as H-a + [NII]
- NII is strong (dominant) in some PNe
- Is there a reason to eliminate NII with a 3 nm H-a filter?
- Or, do you want all photons possible with a =>5 nm H-a filter?
- Other factors – light pollution?

Narrowband Processing Tutorial

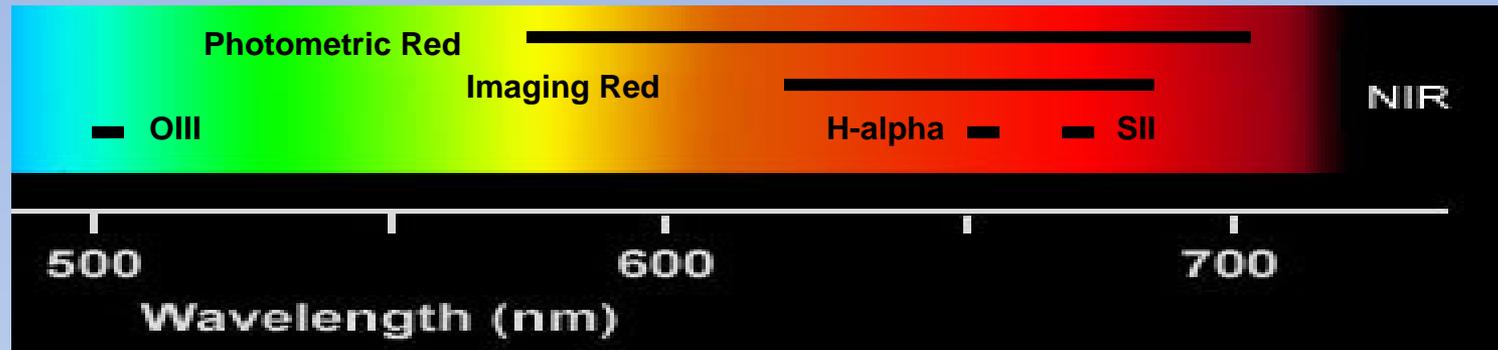


Melotte15 in The Heart Nebula, IC 1805

Goals

- Demonstrate clipping layer mask method
- Achieve rich, vibrant colors
- Improve color of NB Stars
- Add 3-D “feel” to our 2-D data
- Multiscale High-Pass Filtering

Color Mapping



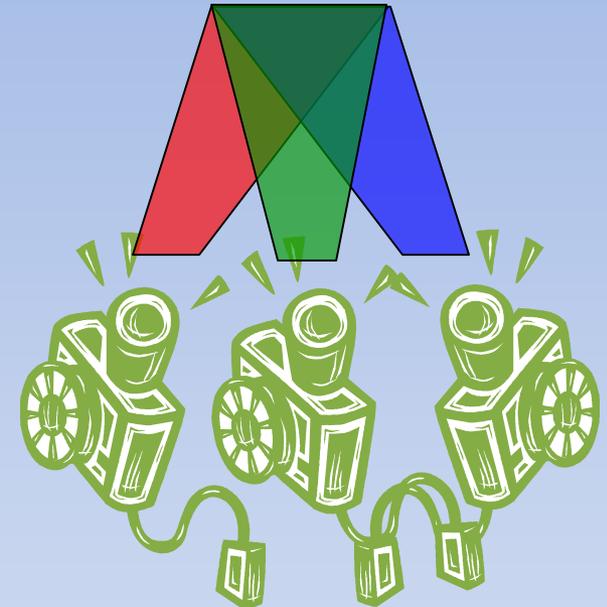
- Combining Blue, Green, Red, is obvious
 - All you need is the weighting
- Bicolor NB (H-a, OIII)
 - Supernova remnants, planetary nebula - natural look
 - $B \sim G = \text{OIII}$, $R = \text{H-a}$
- Tricolor NB (H-a, OIII, SII)
 - Both SII and H-a are red
 - OIII is a mix of green and blue
 - How to color map?
 - Hubble (HST) palette ($B = \text{OIII}$, $G = \text{H-a}$, $R = \text{SII}$) most common
 - CFHT palette ($B = \text{SII}$, $G = \text{OIII}$, $R = \text{H-a}$)
- NB Weights?

NB Color Combine Methods

- Assign RGB in Maxim, CCDStack, Image Plus....
 - Once weights are used and combined, cannot go back
- Preprocess and merge channels in Photoshop
 - www.flemingastrophotography.com (Neil Fleming)
 - Once weights are used and combined, cannot go back
- Clipping Layer Mask
 - <http://www.astrodonimaging.com/docs/RectorImageProcessing.pdf> (Dr. Travis Rector, U. Alaska)
 - <http://www.imagingdeepsky.com/Presentations.html> (Ken Crawford)
 - Very flexible
 - Can change hue, intensity, saturation at any time in the process

Clipping Layer Masks in Photoshop

- Each NB (H-a, SII, OIII) layer is in Screen (projector) blending mode
- Each NB layer has a hue/ saturation layer mask
- Each layer mask is “clipped” only to the NB layer immediately below
- Change hue (color) and intensity for each NB independently at any time in the process
- Can add other clipping layer masks, e.g., curves for each NB



Colors are superimposed in Screen mode as if 3 projectors were used

Melotte 15 in IC 1875 - Masters



H-a 3 nm



OIII 3 nm



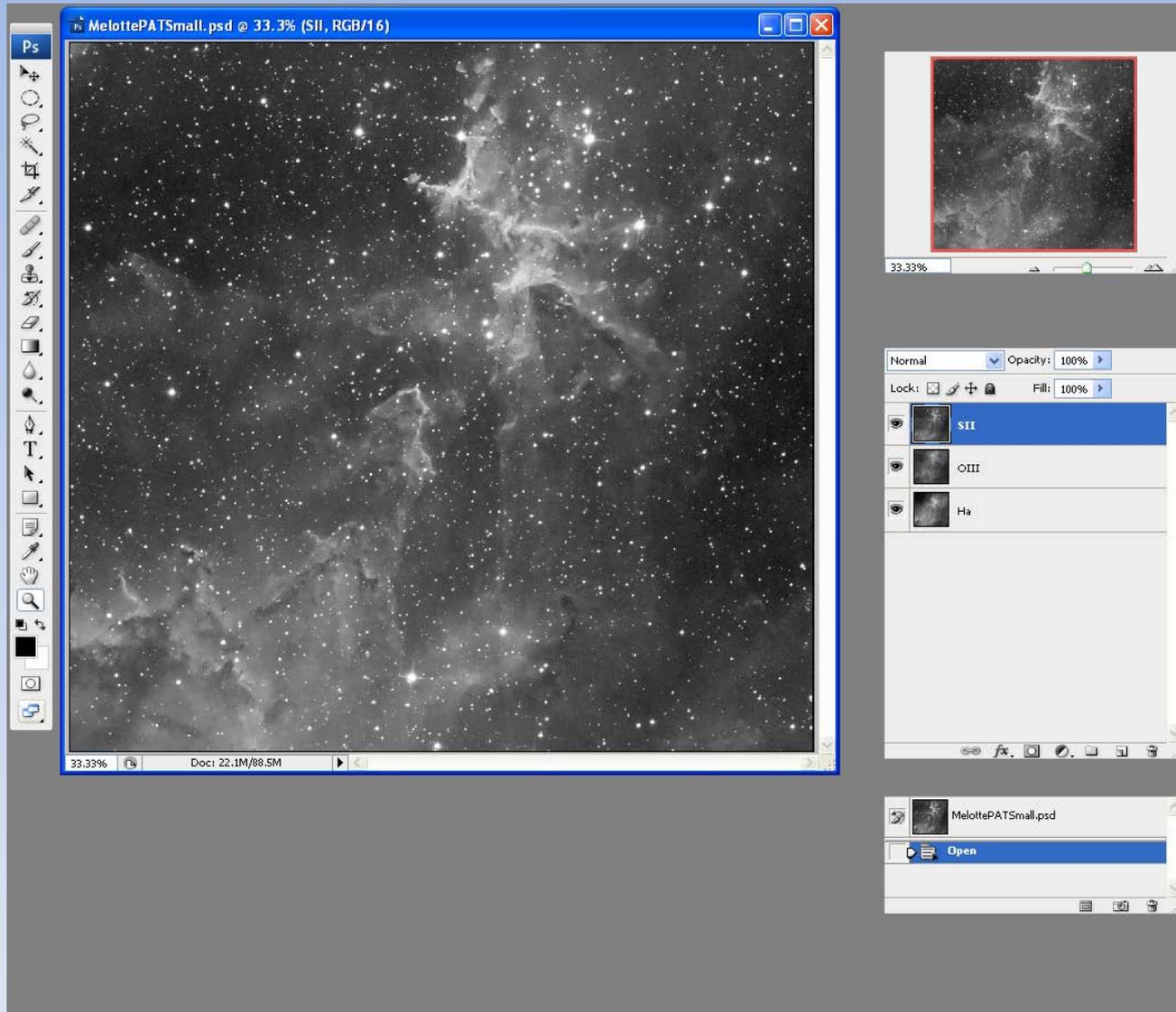
SII 3 nm

Hubble Palette

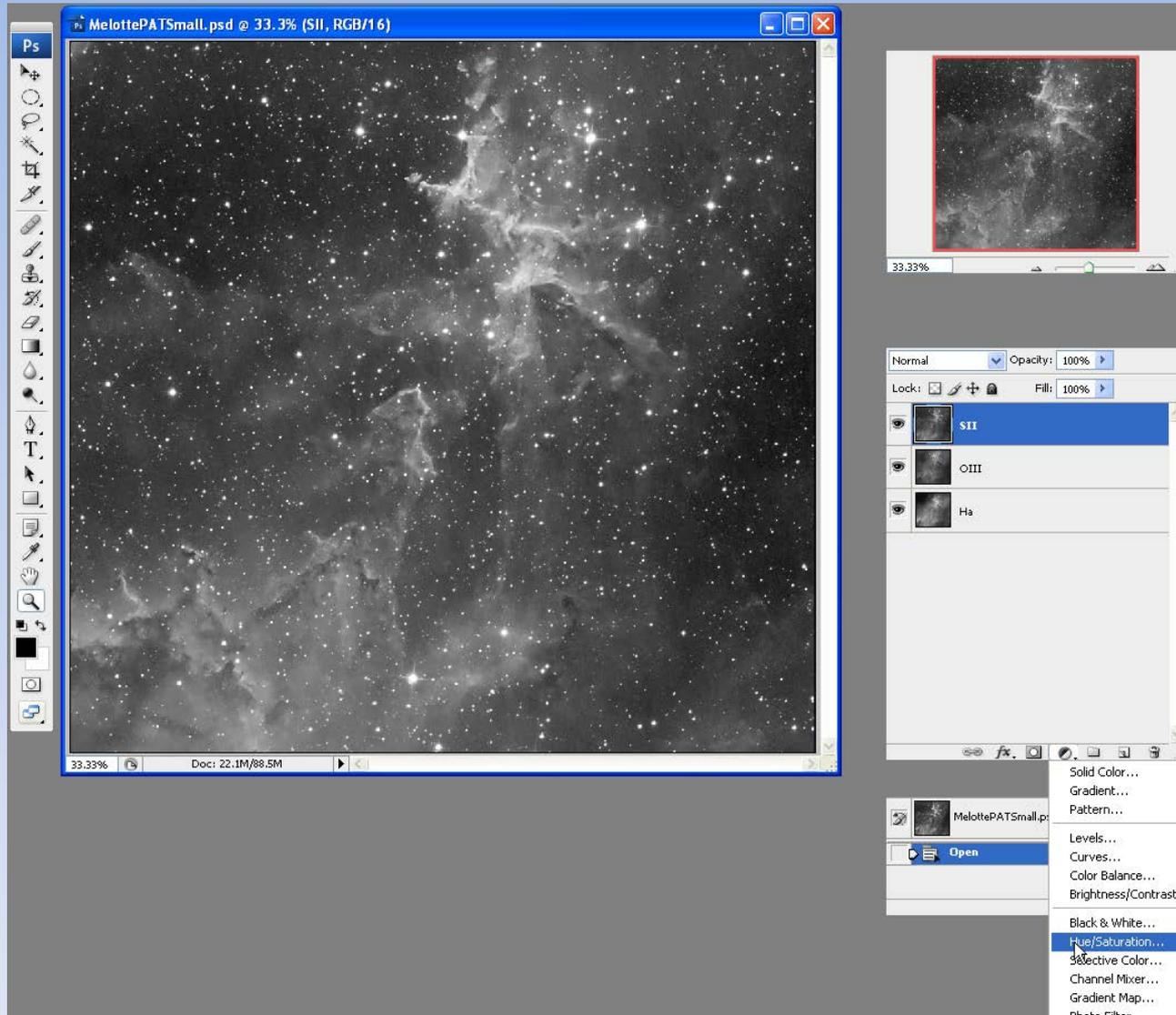
Mapped Color Procedure (Reference)

1. Add H-a, OIII, SII preprocessed, registered 16-bit TIF files and label
2. **Convert image to RGB**
3. Create hue/saturation (H/S) adjustment layer for each layer
 - a) Click Colorize in H/S adjustment layer
 - b) Slide Saturation to 100%
 - c) Slide Lightness to -50
 - d) Slide Hue to 120 for H-a (Green)
 - e) Slide Hue to 240 for OIII (Blue)
 - f) Slide Hue to 360 (Red) for SII
 - g) Right click adjustment layer and select “create clipping layer mask”
4. Select “Screen” blending mode for H-a, SII and OIII image layers (not layer masks)
5. Adjust lightness to taste
6. Add curves adjustment layers as needed

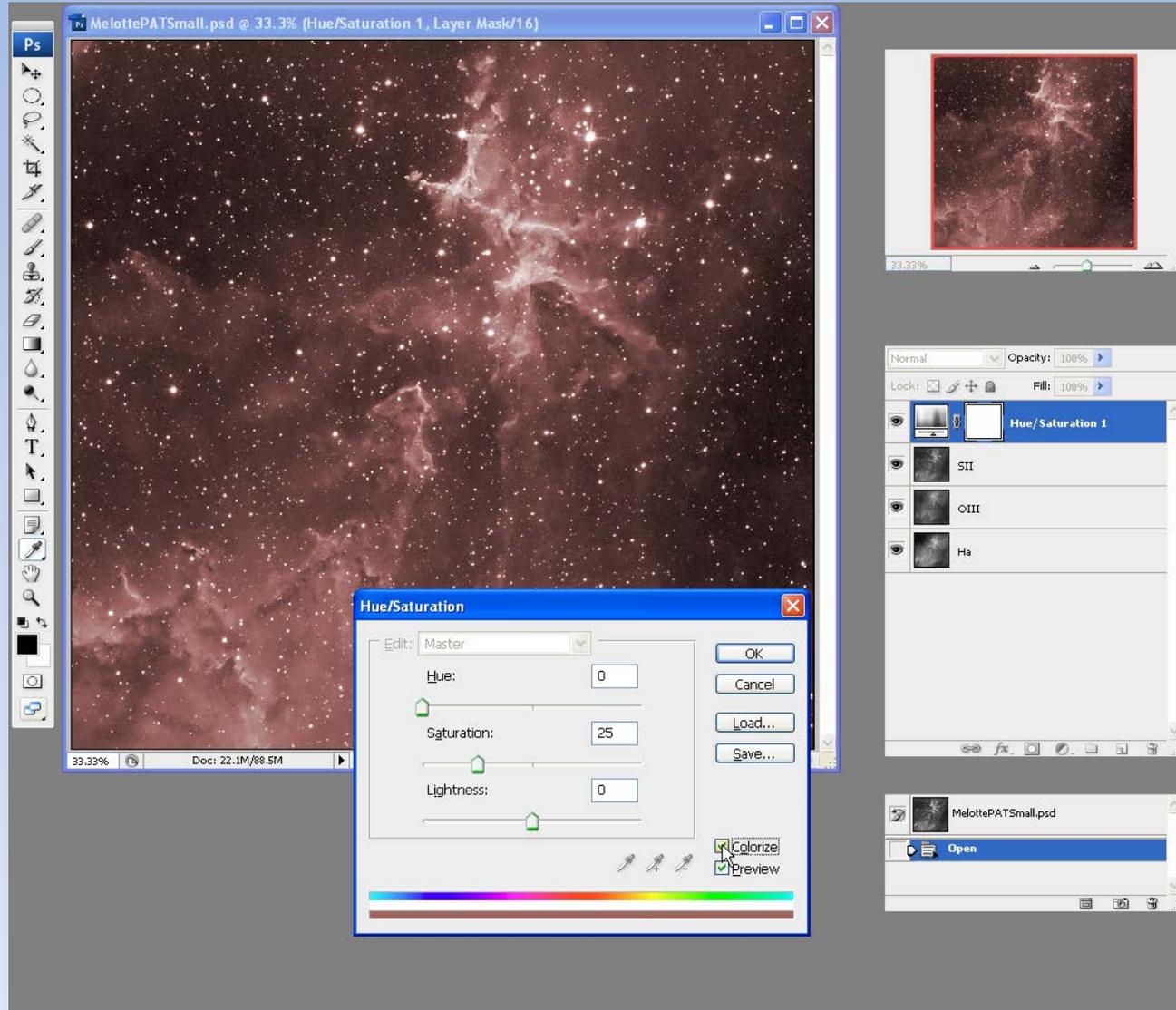
Clipping Layer Mask SII



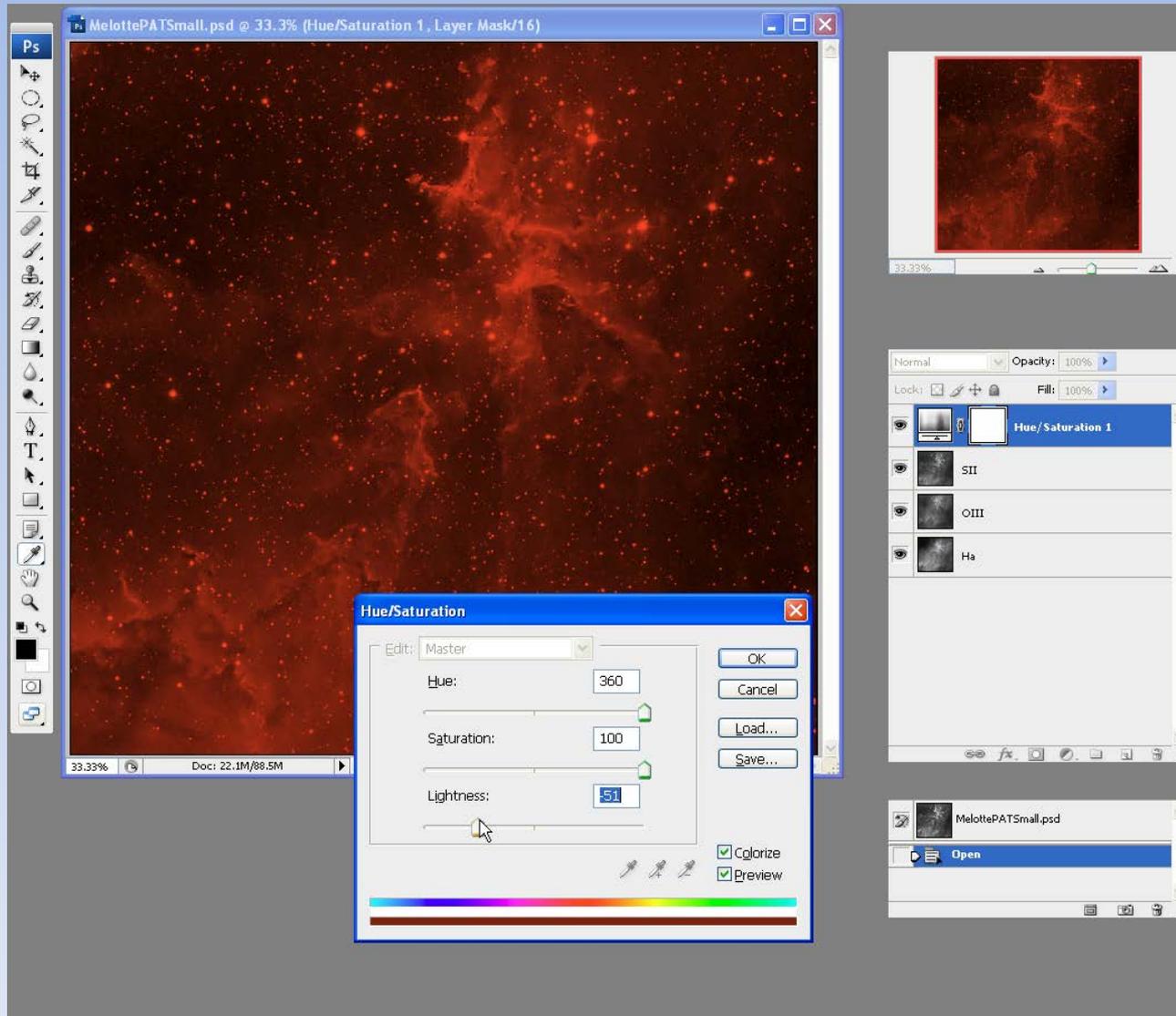
Clipping Layer Mask SII



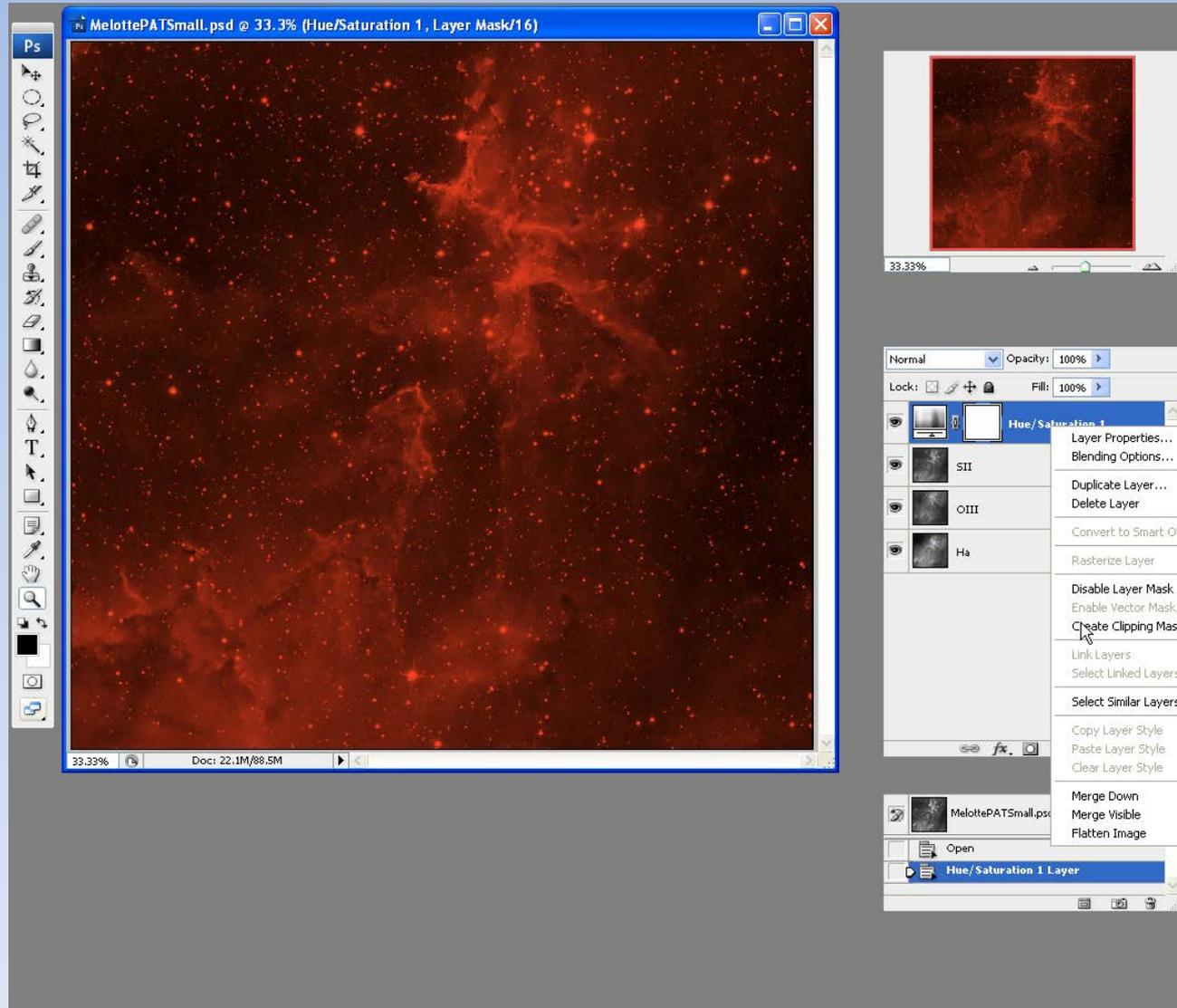
Clipping Layer Mask SII



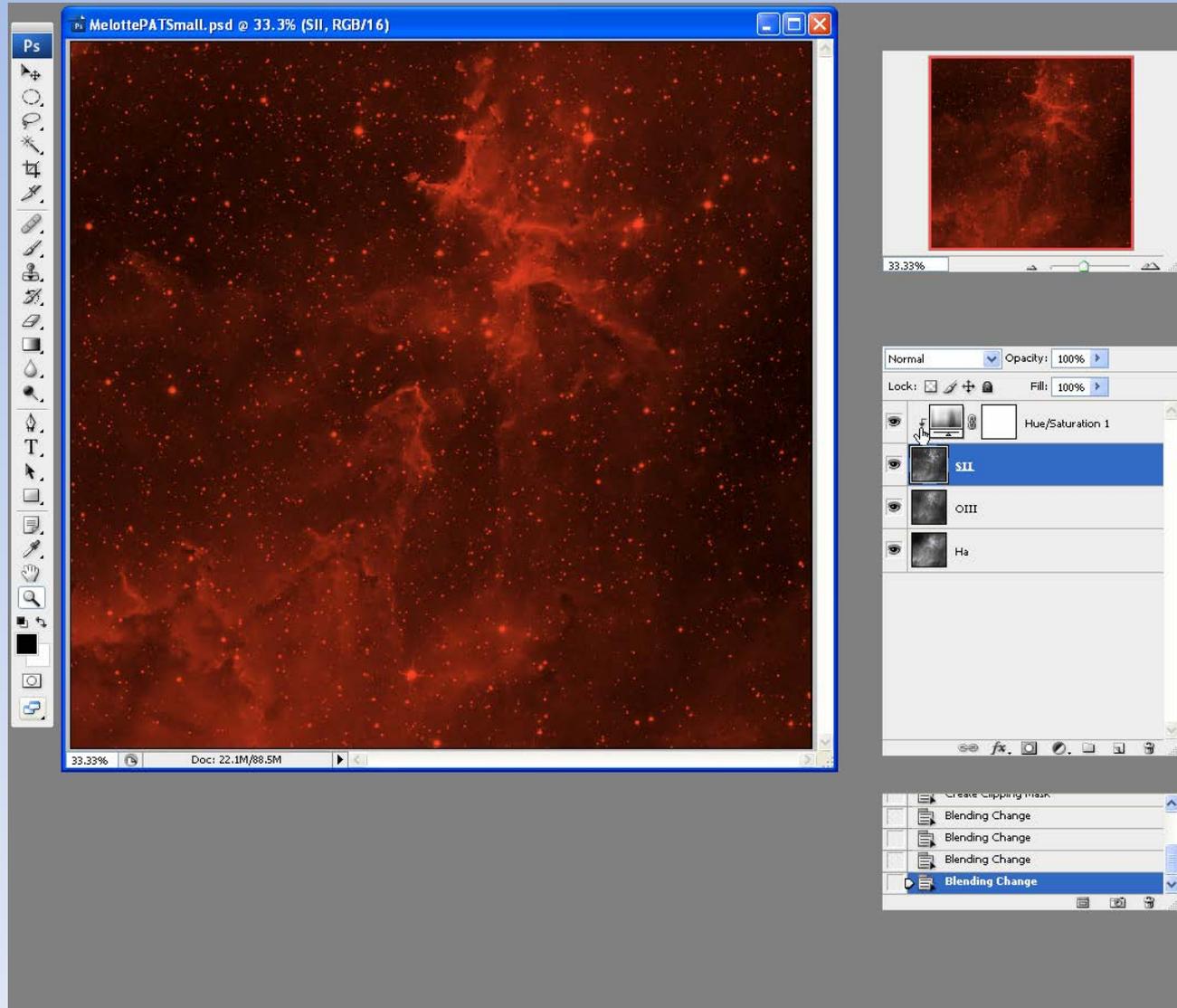
Clipping Layer Mask SII



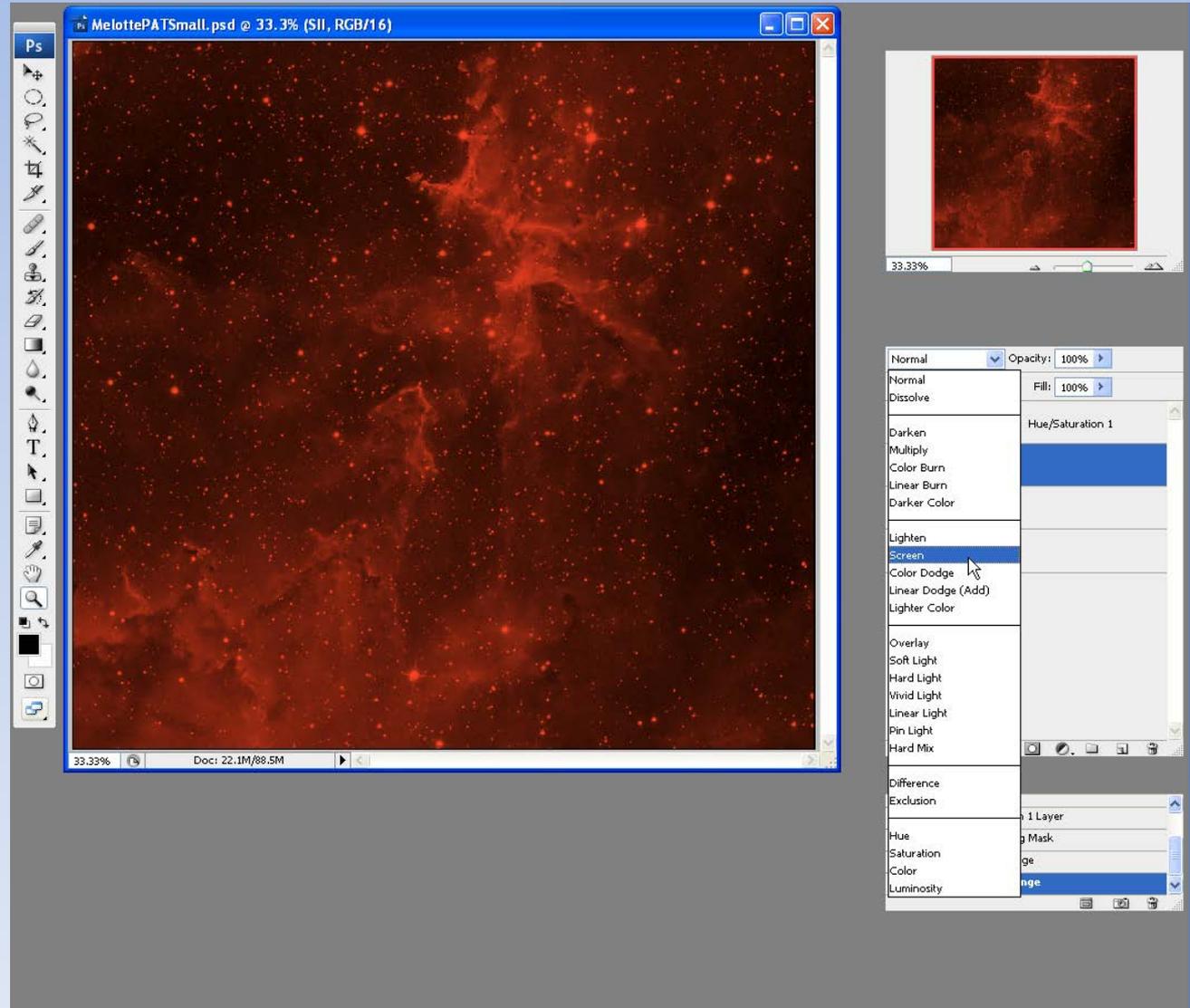
Clipping Layer Mask SII



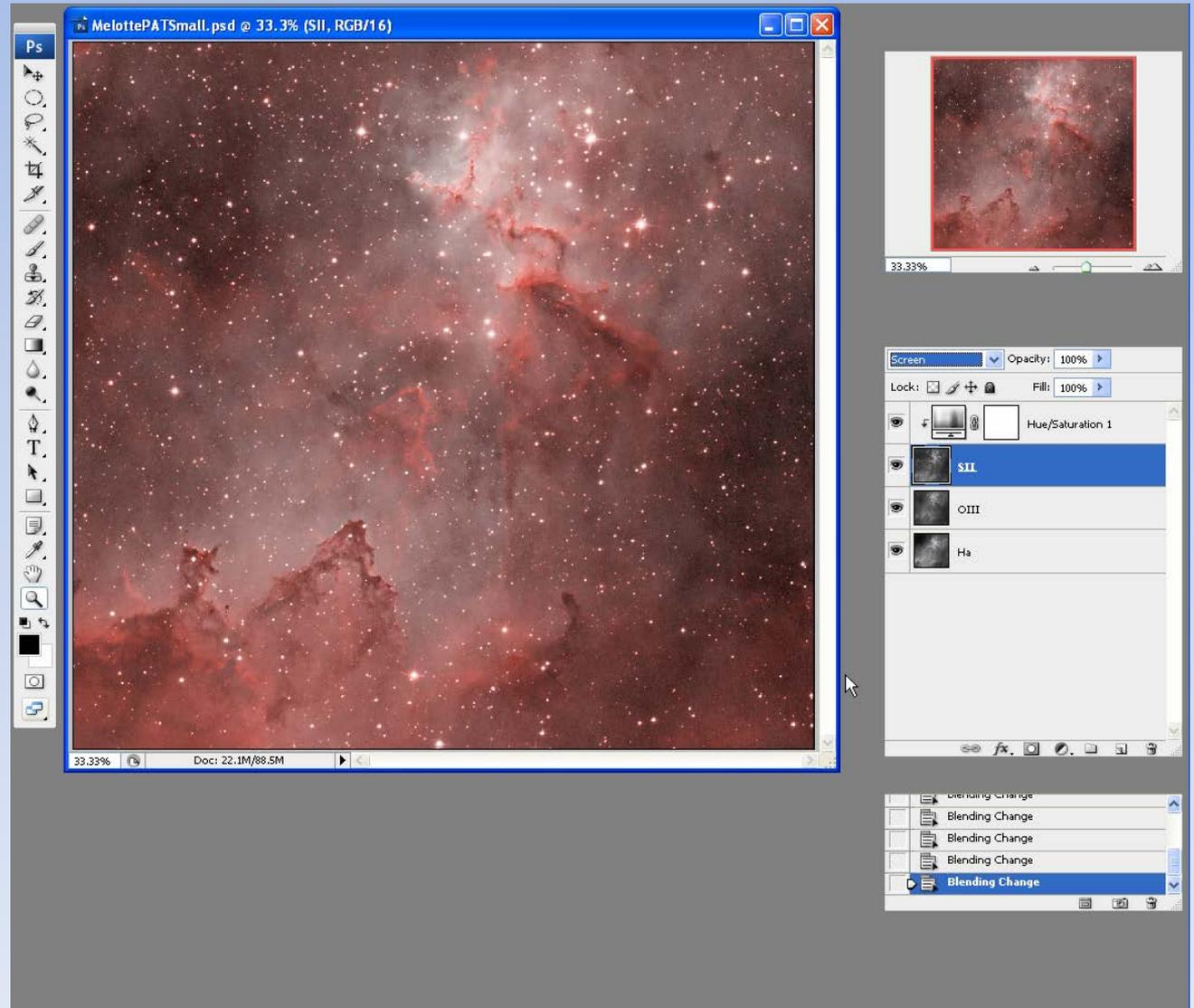
Clipping Layer Mask SII



Clipping Layer Mask SII

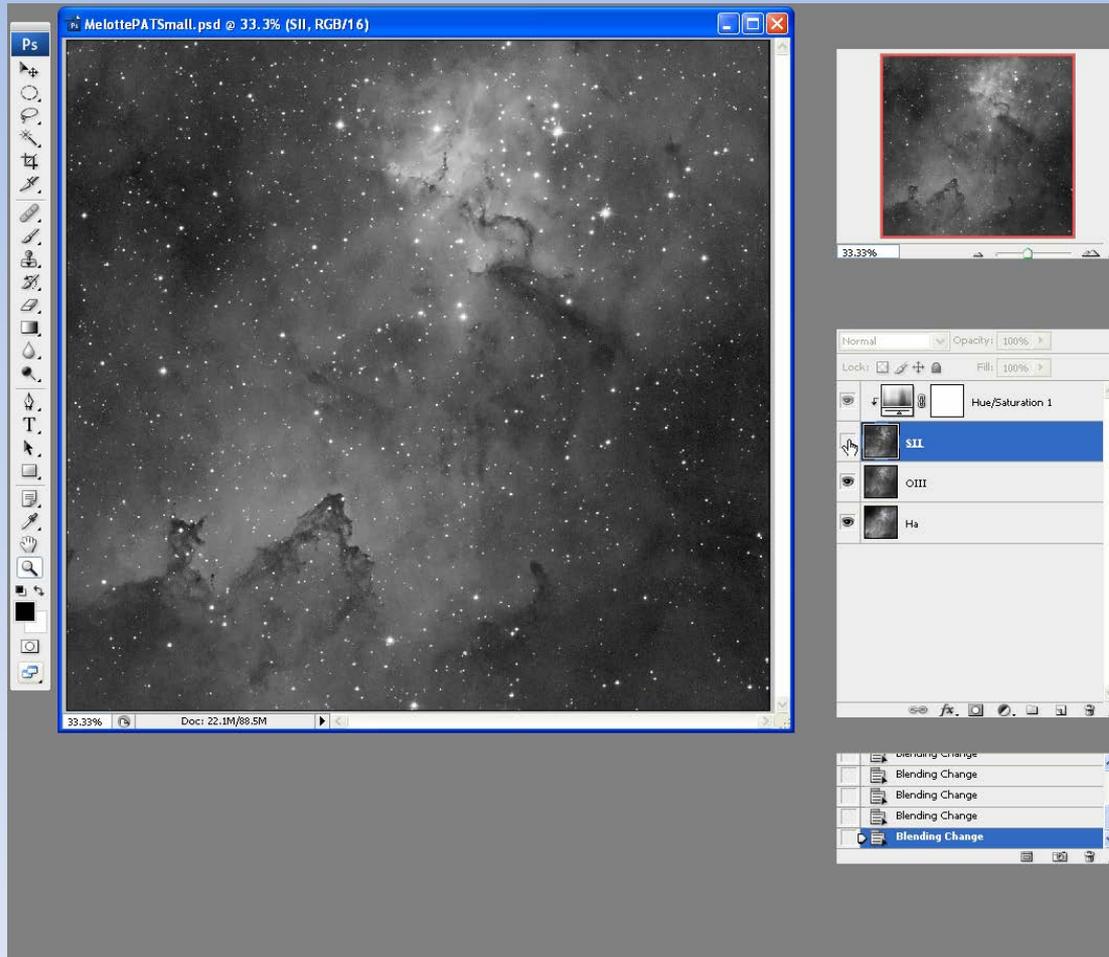


Clipping Layer Mask SII



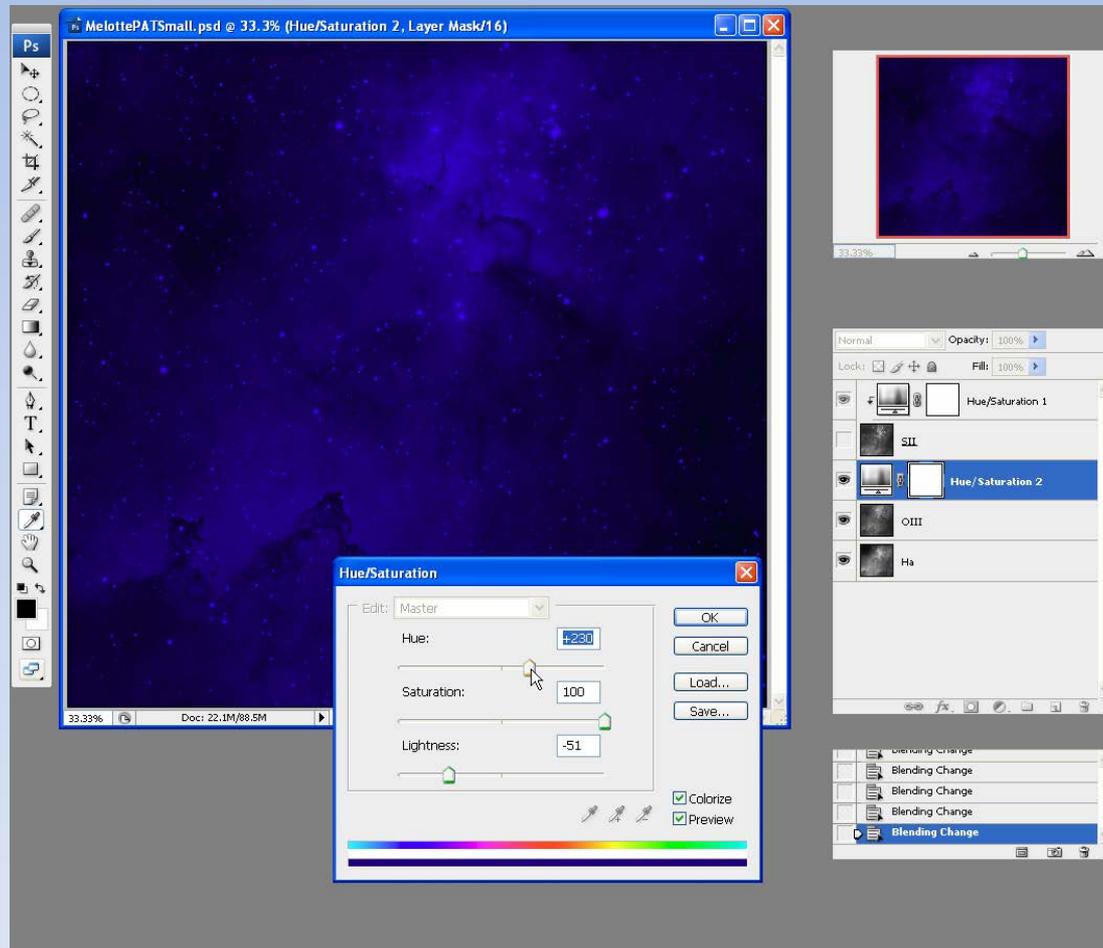
Repeat for OIII

Turn off current screen layer to see layer below



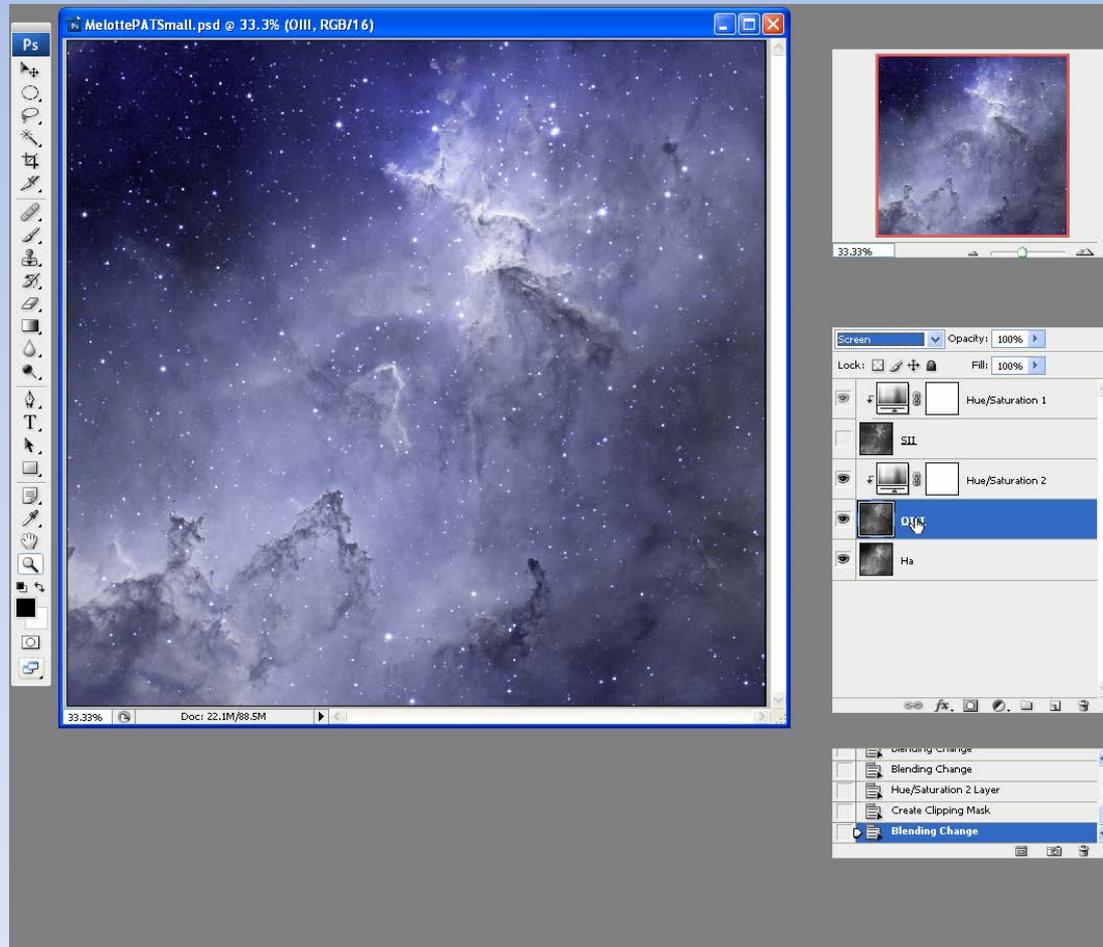
Repeat for OIII

Turn off current screen layer to see layer below



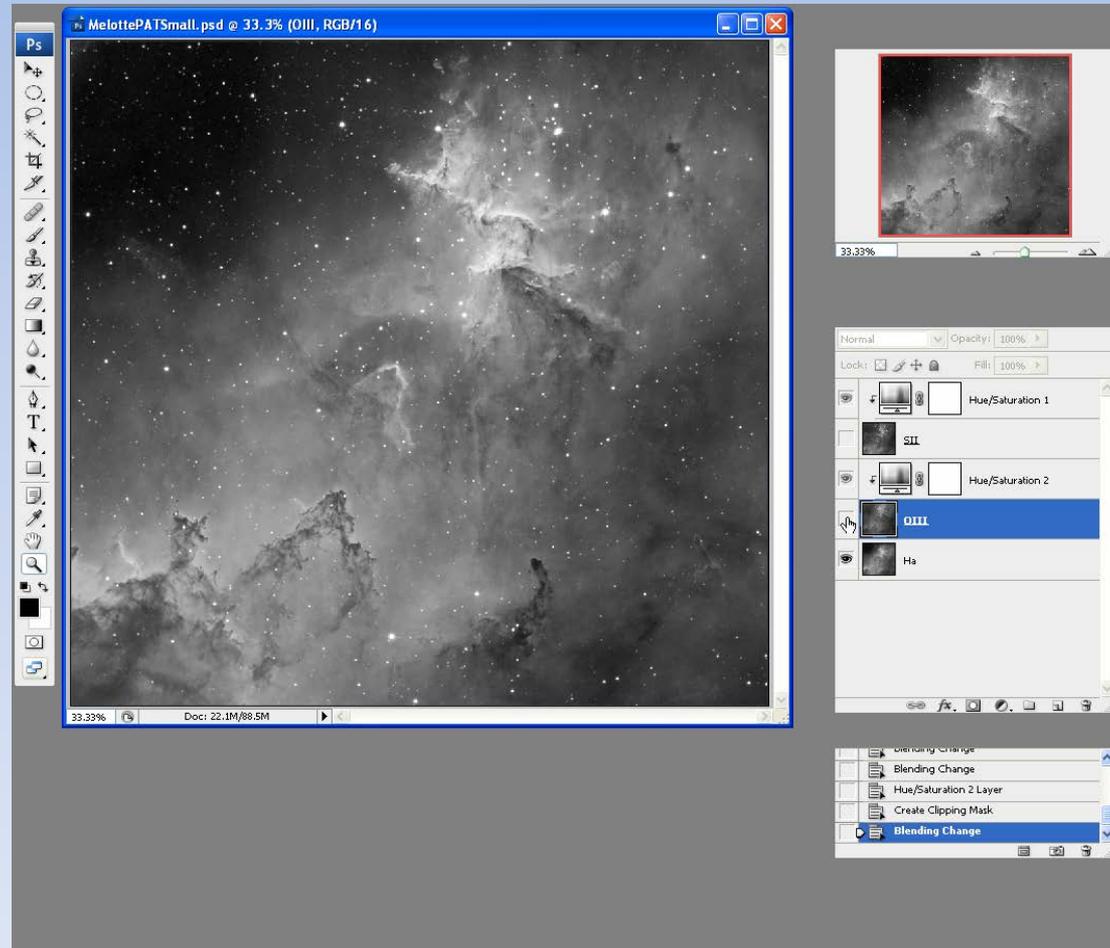
Repeat for OIII

Turn off current screen layer to see layer below

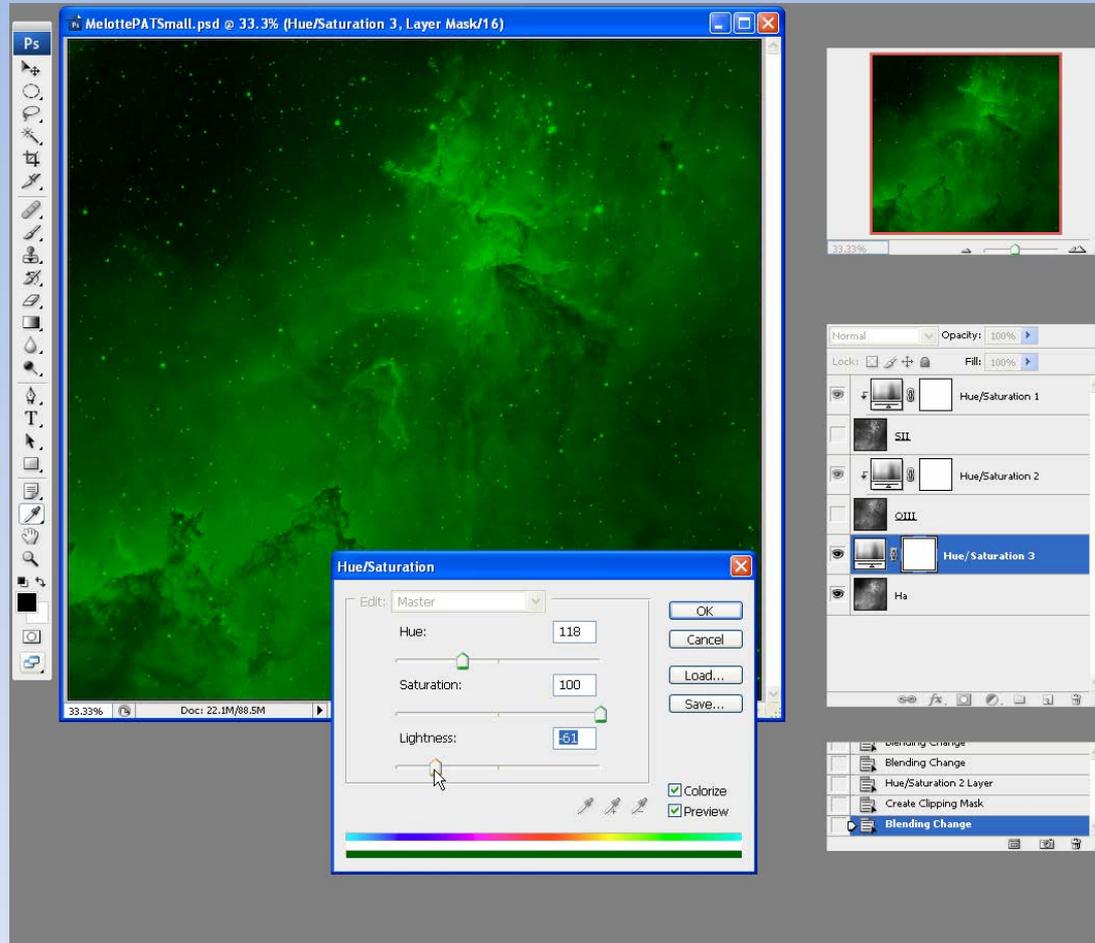


Repeat for OIII

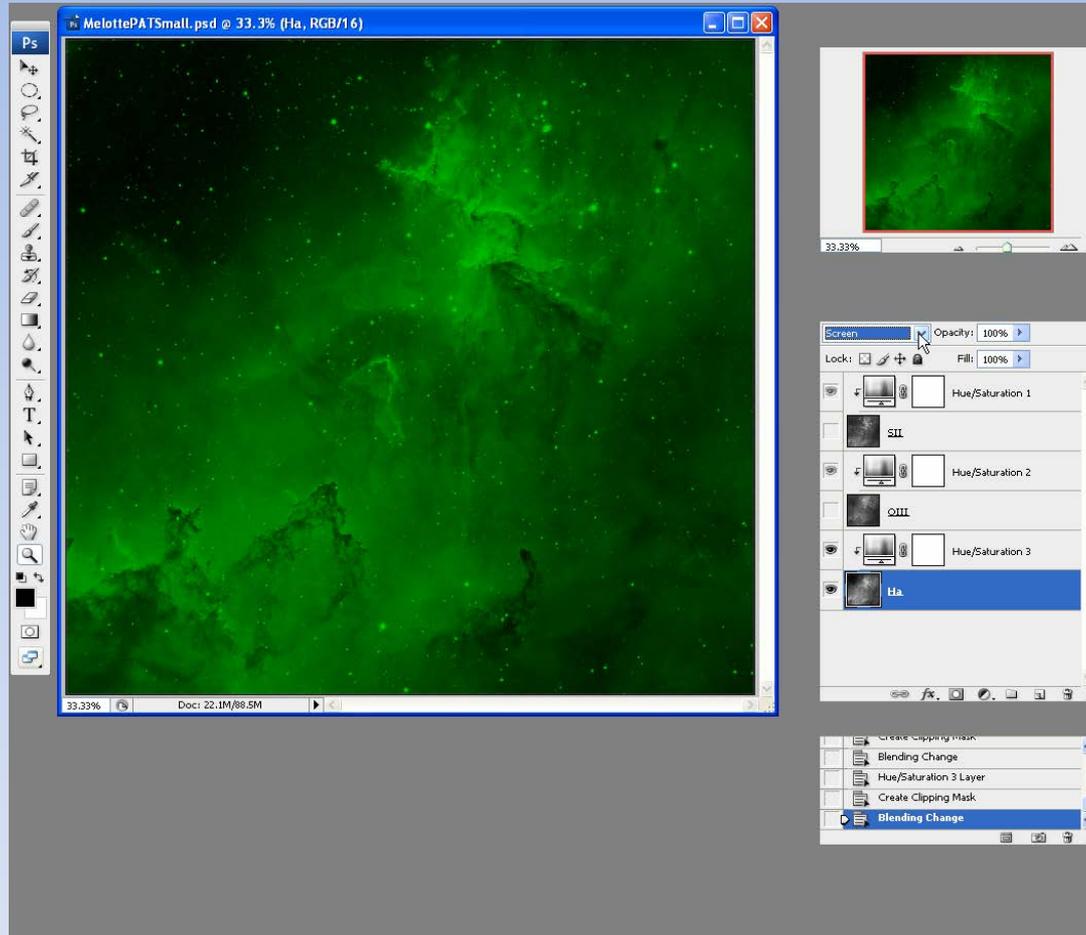
Turn off current screen layer to see layer below



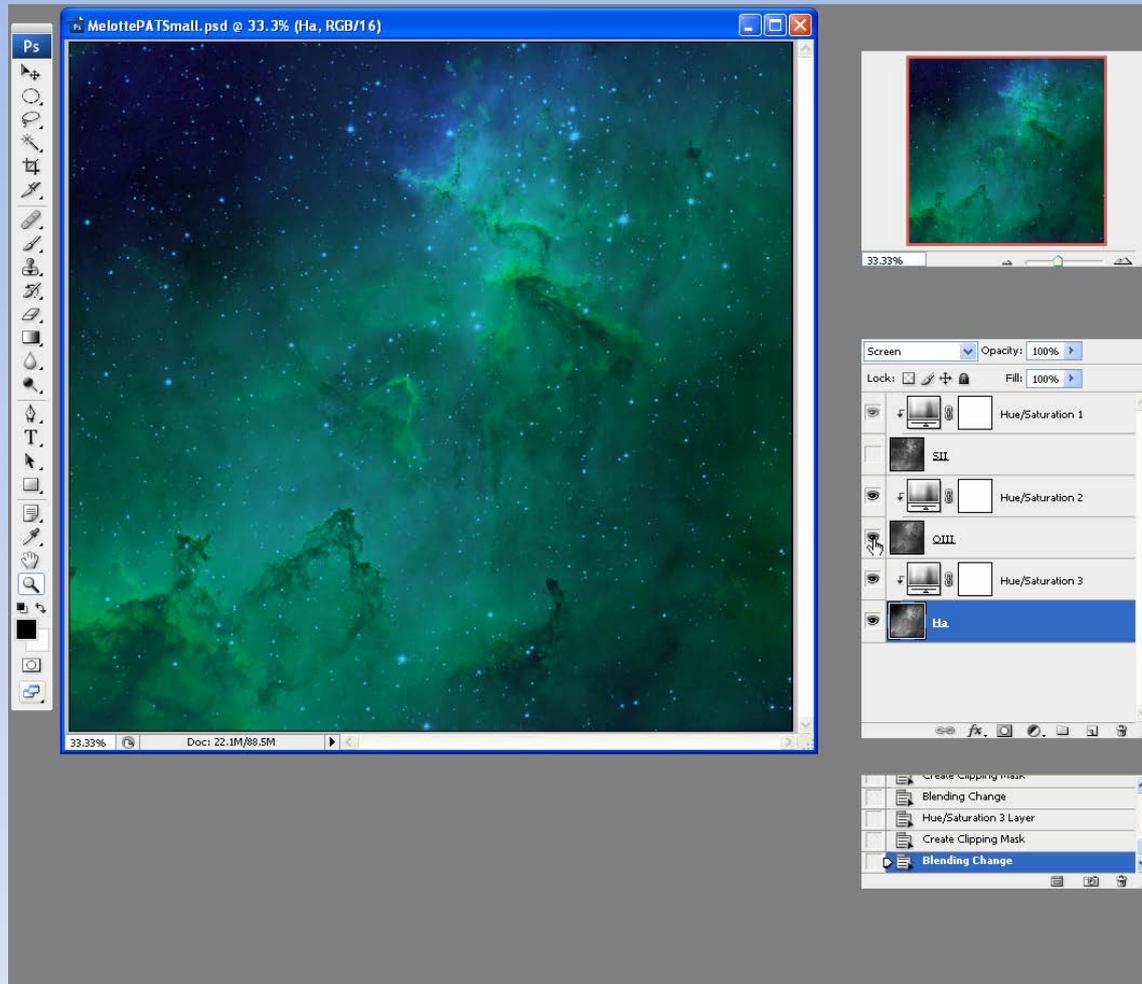
Complete with H-a



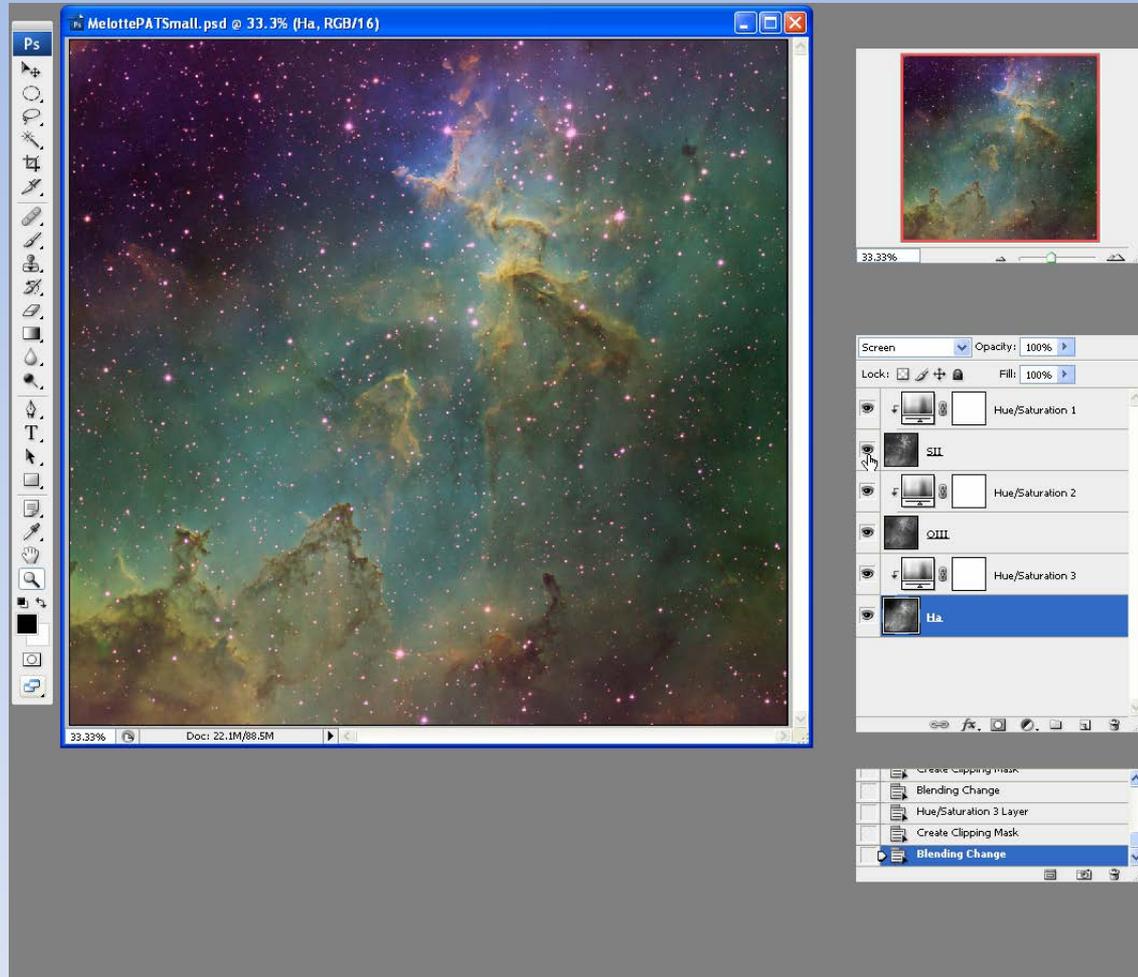
Complete with H-a



Turn Other Layers On



Turn Other Layers On



Adjust SII Overall Intensity

- Double click on H/S SII adjustment layer
- Change the Lightness from -51 to -42

The image displays a Photoshop workspace with two side-by-side panels of a nebula image. The left panel shows the original image, and the right panel shows the result after adjusting the SII layer's lightness. A 'Hue/Saturation' dialog box is open over the right panel, with the 'Lightness' slider set to -42. The 'Hue' is set to 360 and 'Saturation' is 100. The 'Layers' panel on the right shows the 'Hue/Saturation 1' layer selected. The 'Properties' panel shows the 'Blending Change' layer selected. The 'Layers' panel also shows other adjustment layers: 'SII', 'Hue/Saturation 2', 'Hue/Saturation 3', and 'H/S'.

MeiottePATSmall.psd @ 33.3% (Hue/Saturation 1, Layer Mask/16)

MeiottePATSmall.psd @ 33.3% (Hue/Saturation 1, Layer Mask/16)

Hue/Saturation

Edit: Master

Hue: 360

Saturation: 100

Lightness: -42

OK Cancel Load... Save...

Colorize Preview

Normal Opacity: 100% Fill: 100%

Locks

Hue/Saturation 1

SII

Hue/Saturation 2

Hue/Saturation 3

H/S

Create Clipping Mask

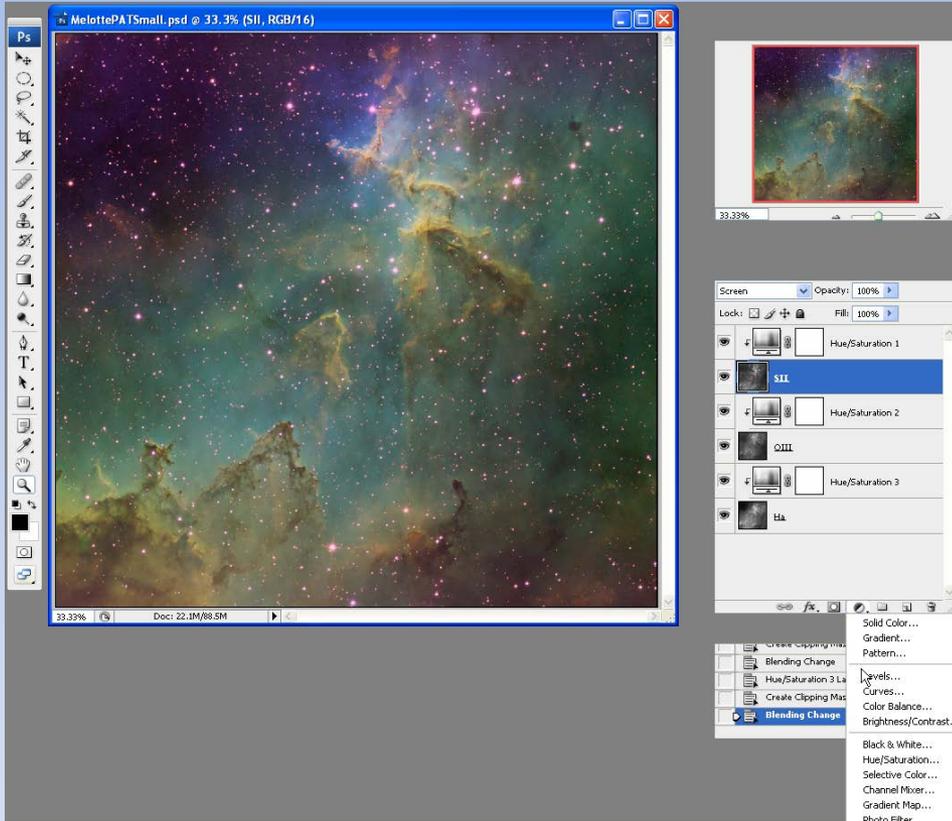
Blending Change

Hue/Saturation 3 Layer

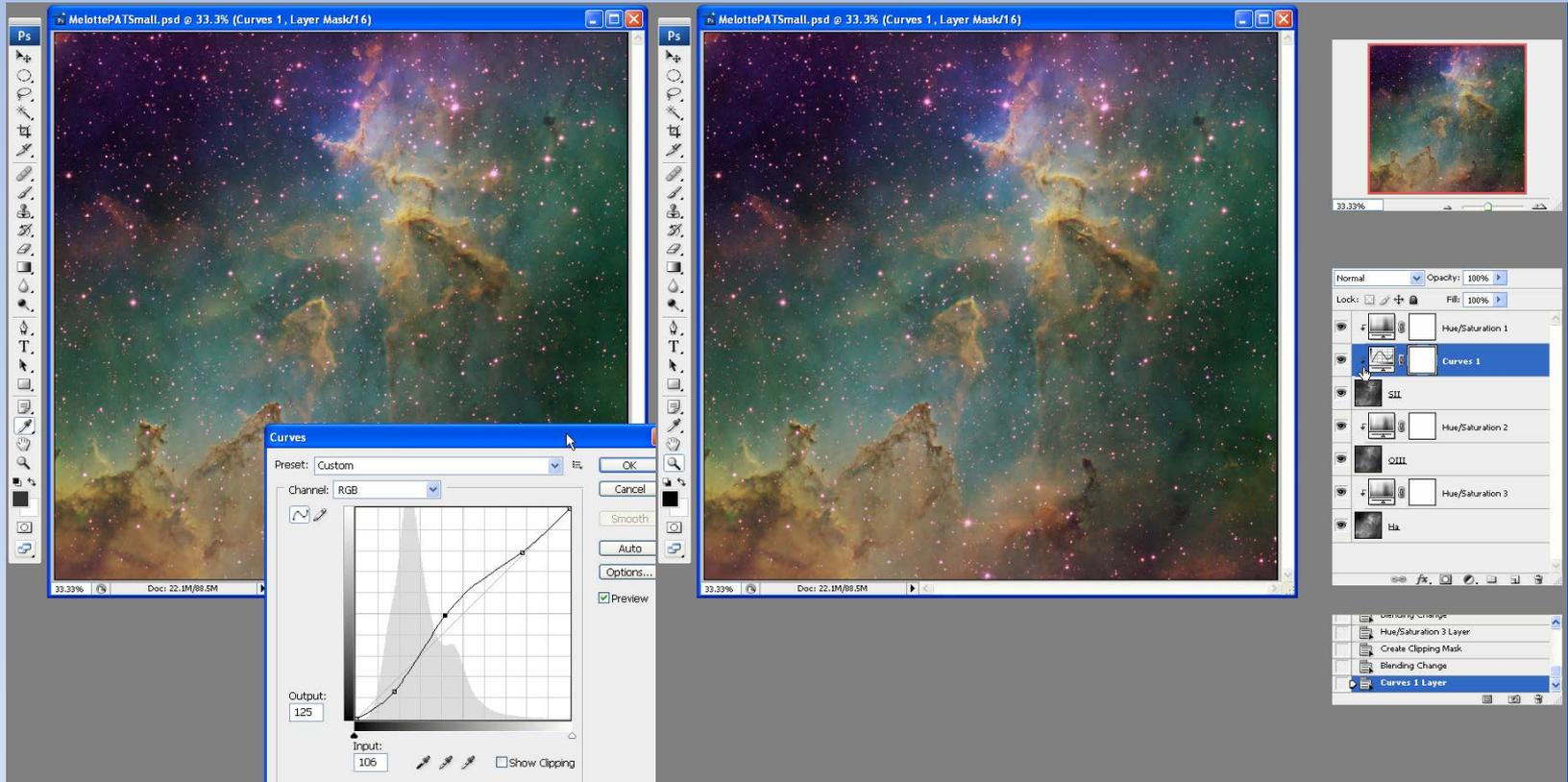
Create Clipping Mask

Blending Change

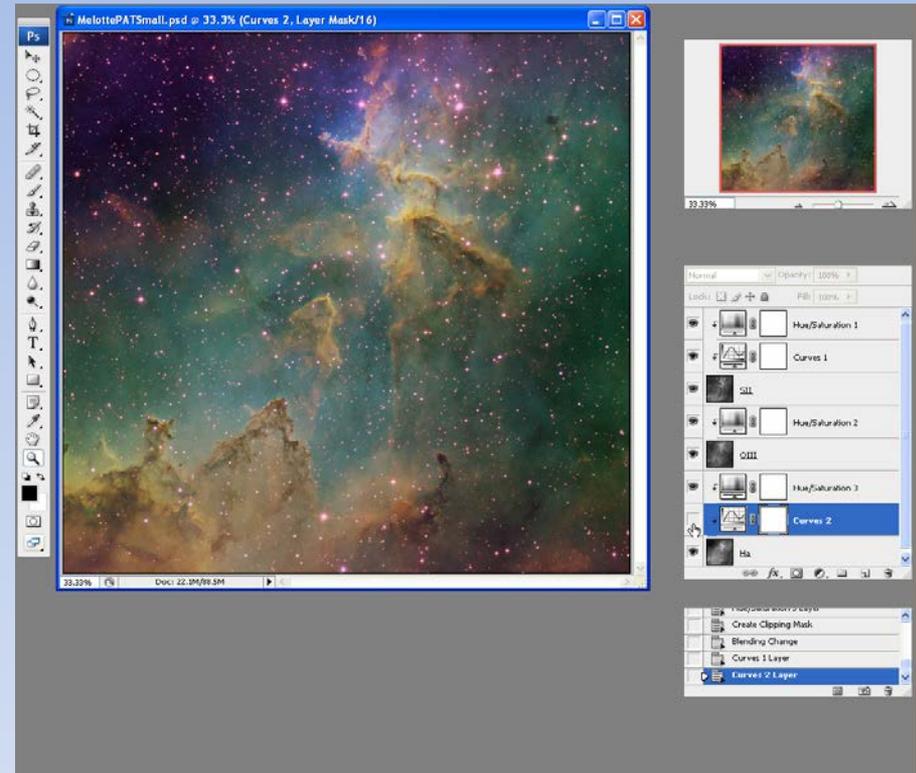
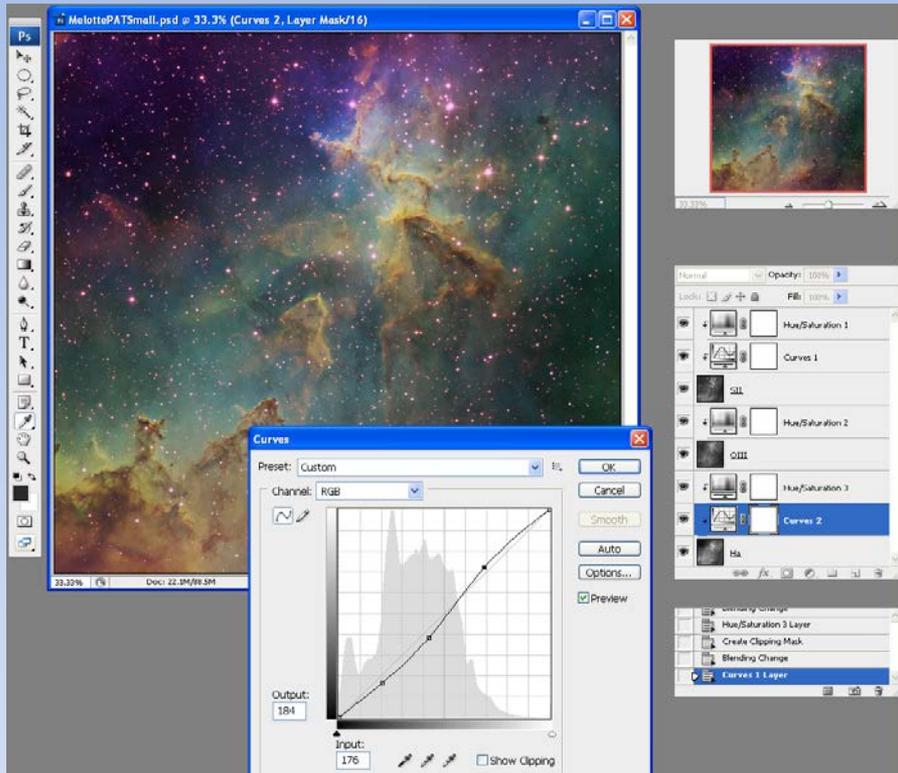
Add SII Curves Clipping Layer Mask



Add SII Curves Clipping Layer Mask



Add H-a Curves Clipping Layer Mask

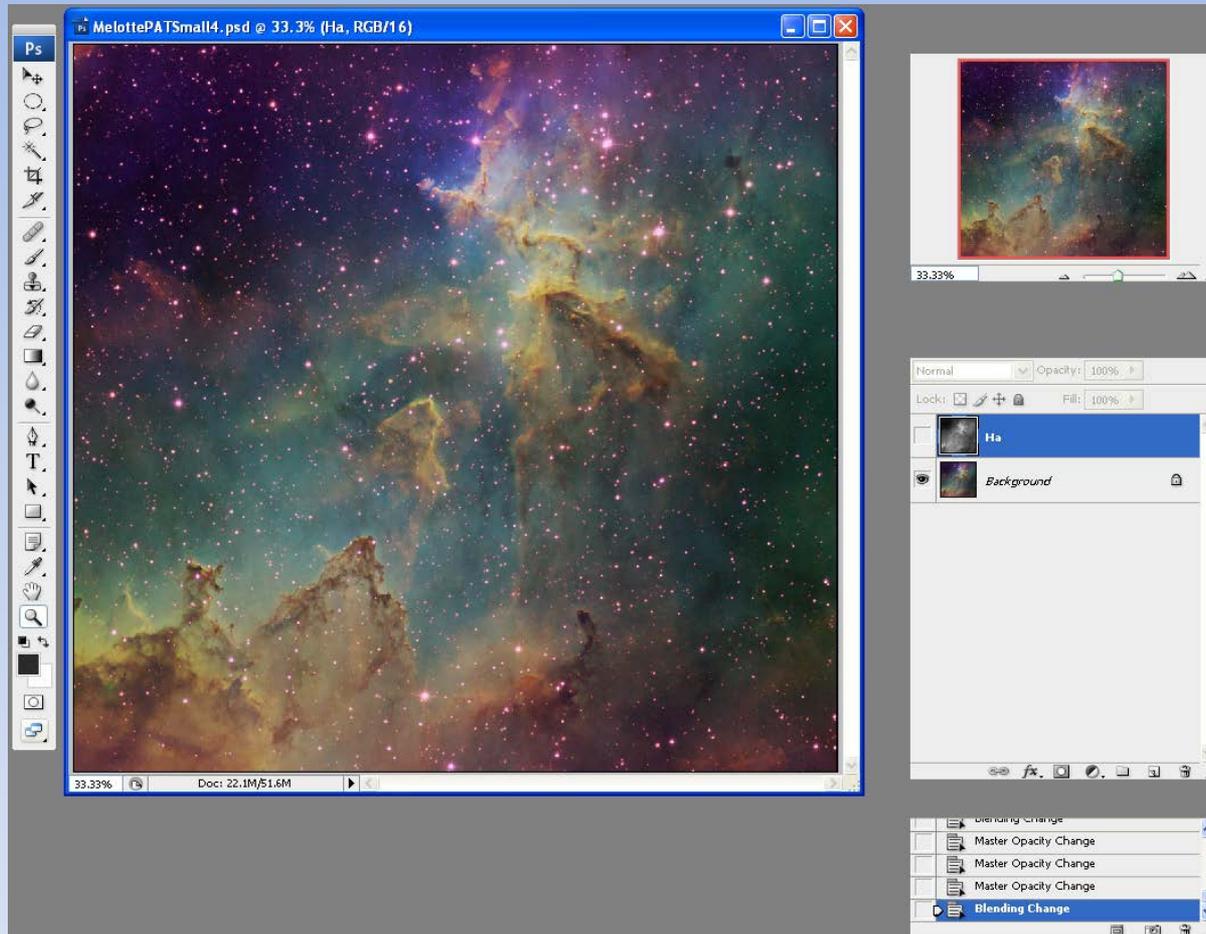


If you don't like it, just turn the curves layer off. Cannot turn off the Hue/Saturation layer.

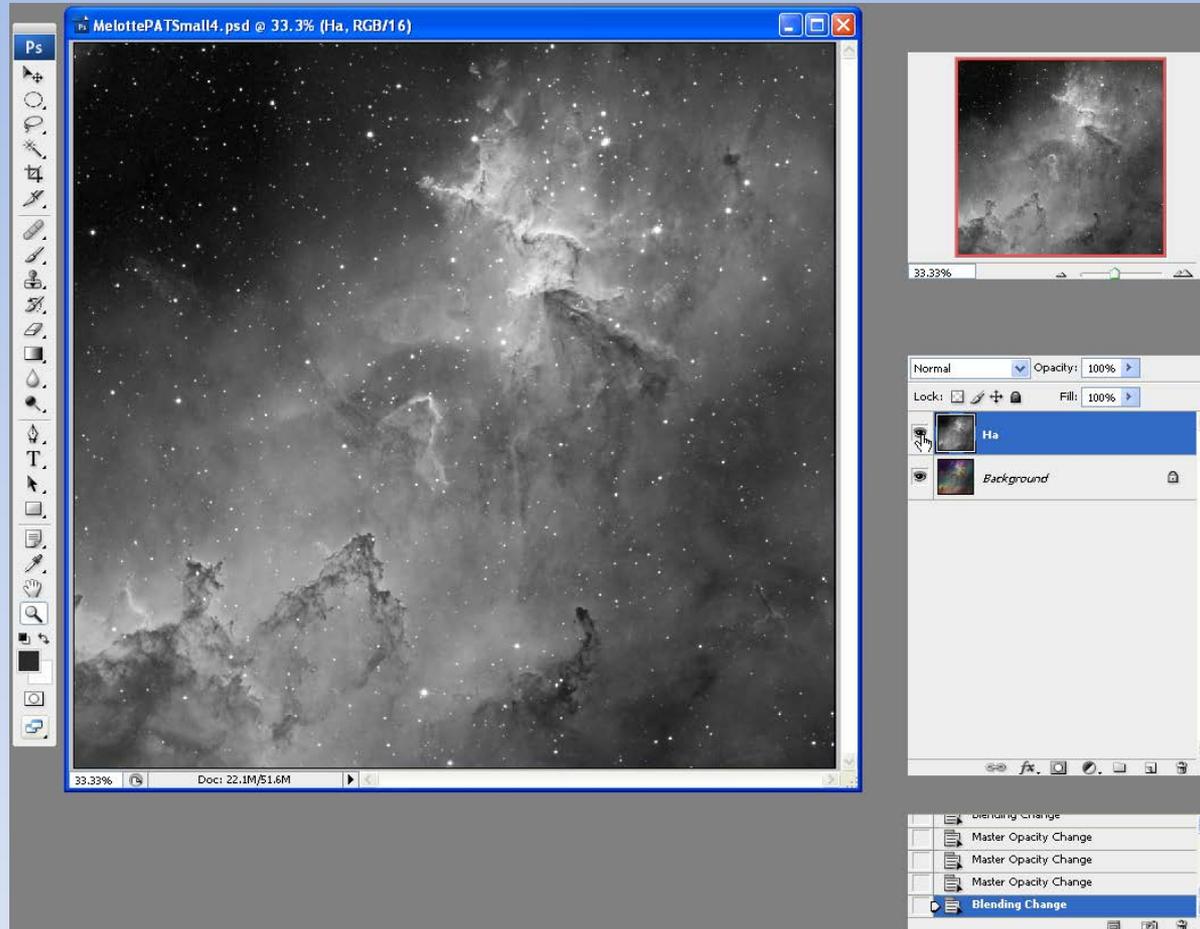
Using NB Luminance

- H-a luminance will only emphasize H-a and de-emphasize OIII and SII
- Make a “super-luminance”
- H-a + OIII + SII (e.g., CCDStack)
- Add layer to flattened NB image
- Change blending mode to “luminosity”
- Adjust “opacity”

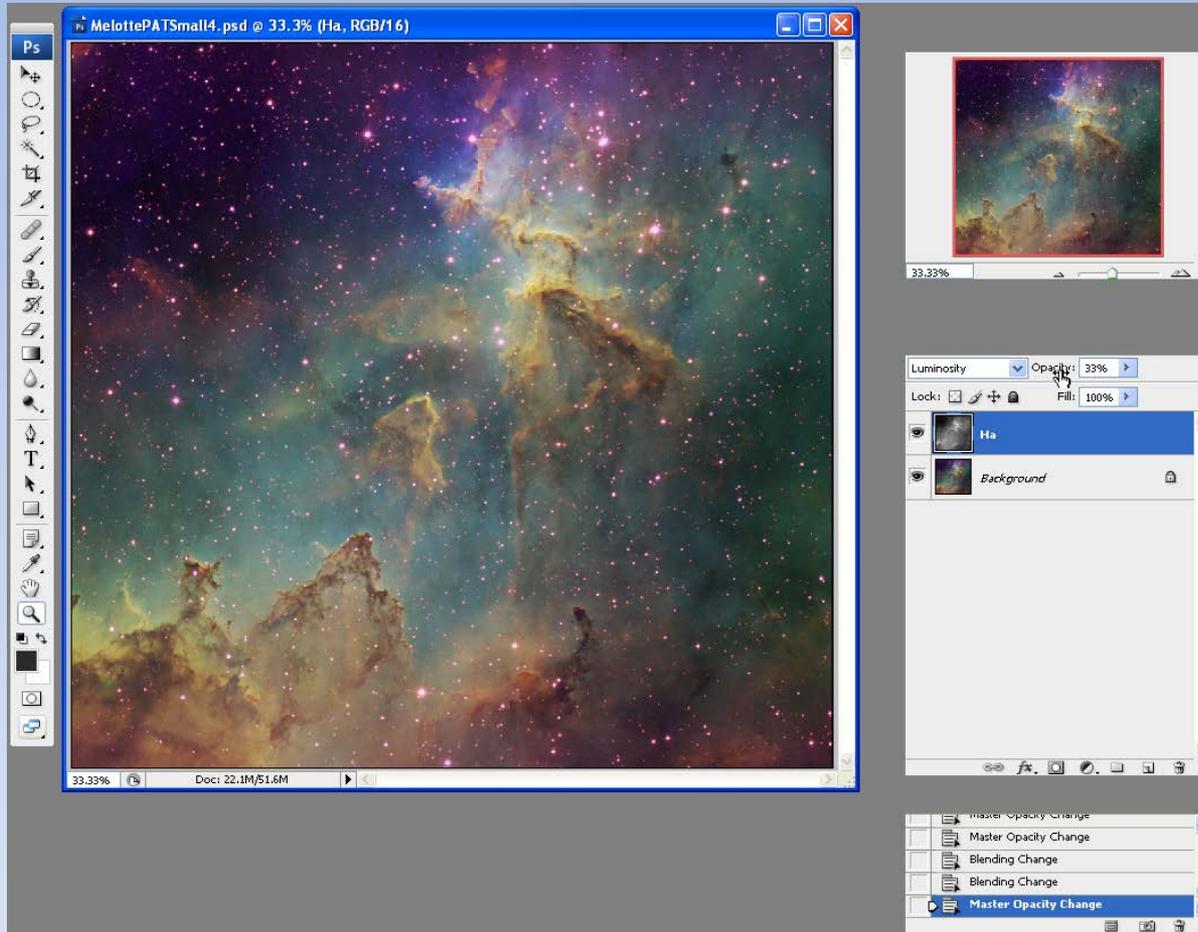
NB Luminance



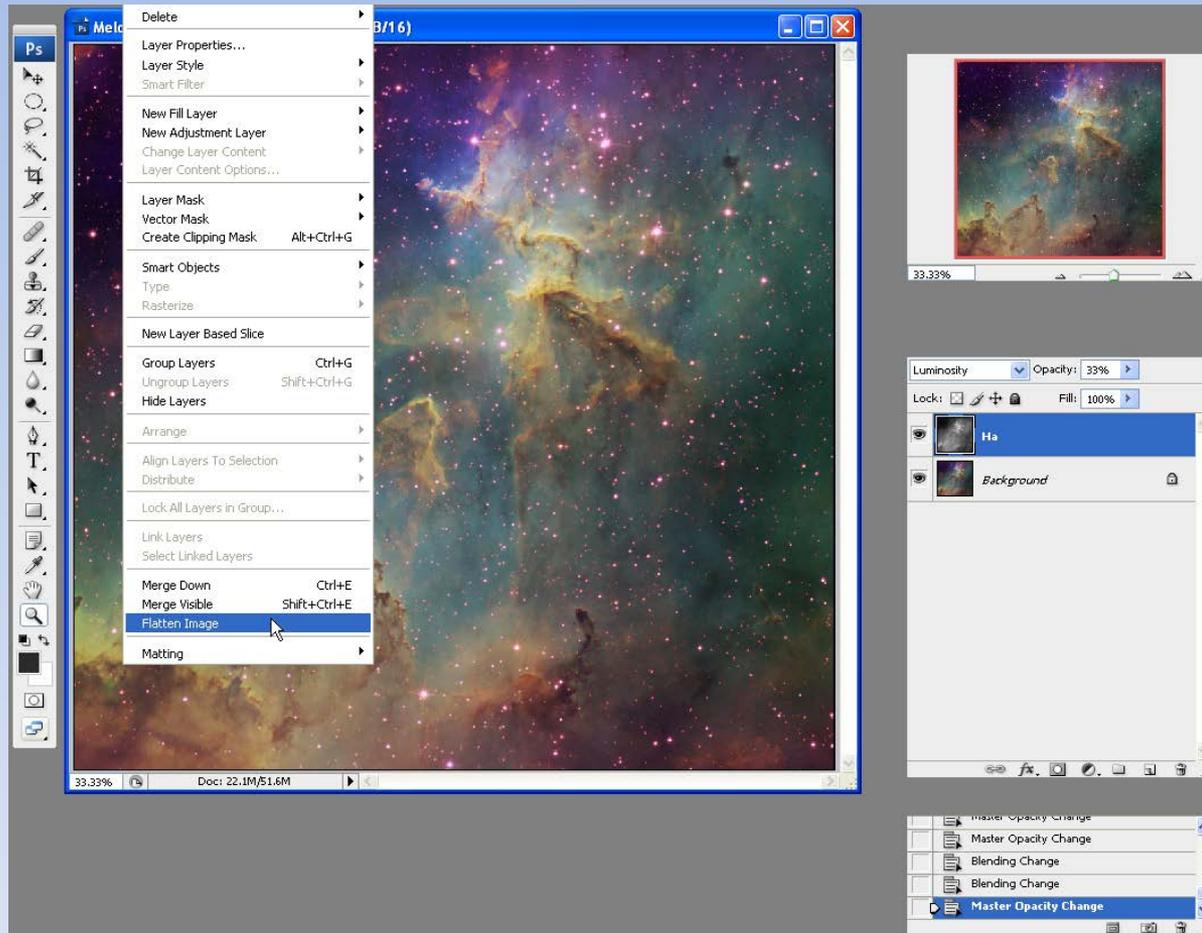
NB Luminance



NB Luminance



NB Luminance

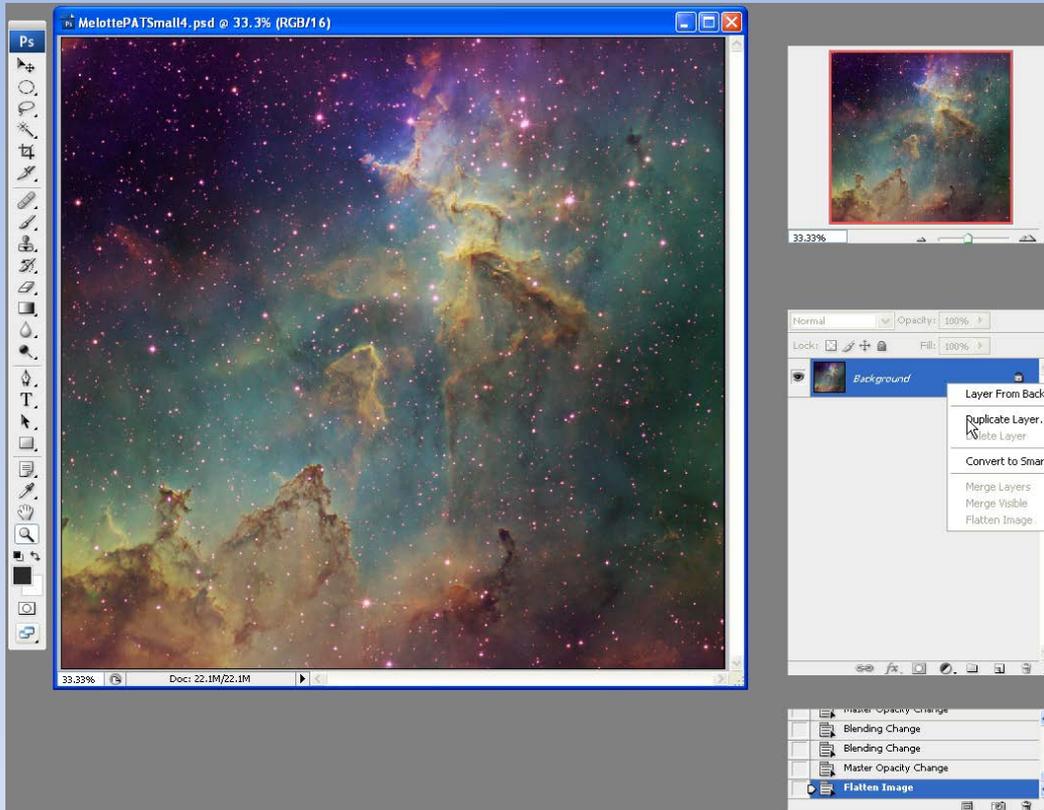


Photoshop Procedure (Reference)

Selective High-Pass Filtering

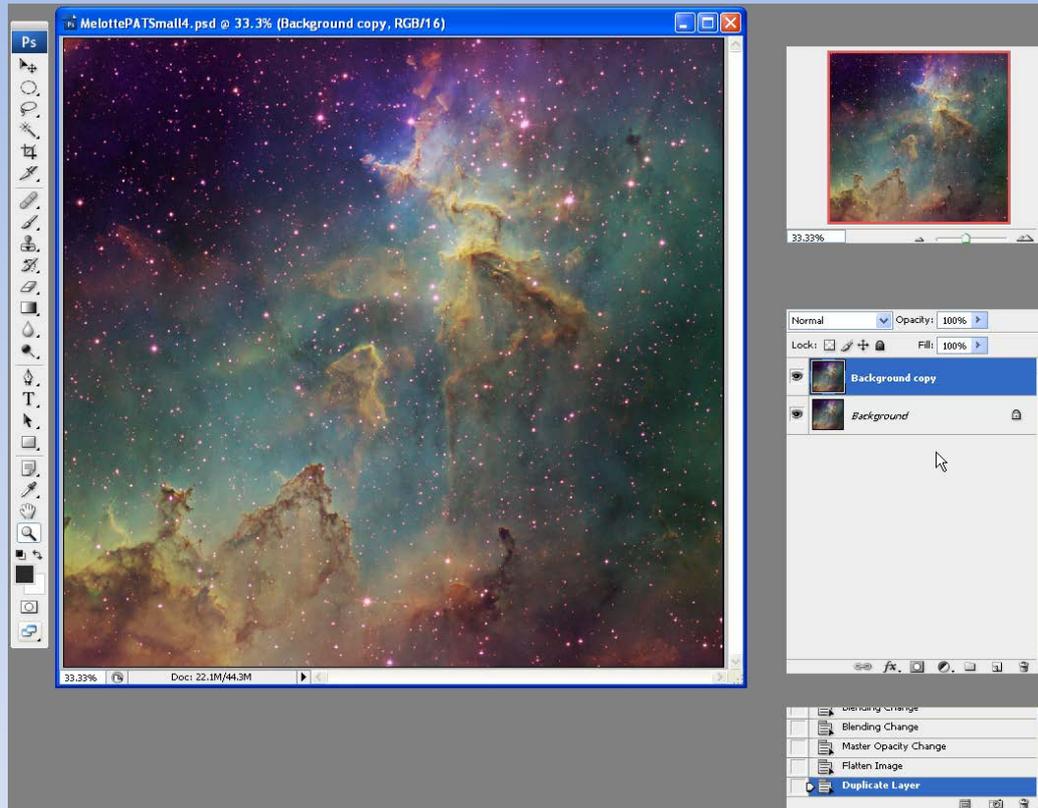
1. Save PSD file
2. Duplicate and flatten image to have one layer
3. Duplicate layer
4. Select Filter/Other/High Pass
5. Select a pixel scale of ~7 for sharp detail (e.g., tendrils)
6. Select a pixel scale of ~35-45 for large scale (e.g., galaxy arms)
7. Change the blending mode to overlay (sharper) or soft light
8. Adjust opacity to taste
9. Select hide-all layer mask from Layers
10. Use brush in foreground (white) mode
11. Adjust brush size
12. Paint over just the areas you want sharpened avoiding stars
13. Collapse and save as single-layer 16-bit TIF for prints
14. Save 8-bit 72 dpi JPEG file for posting

High Pass Filtering in Photoshop



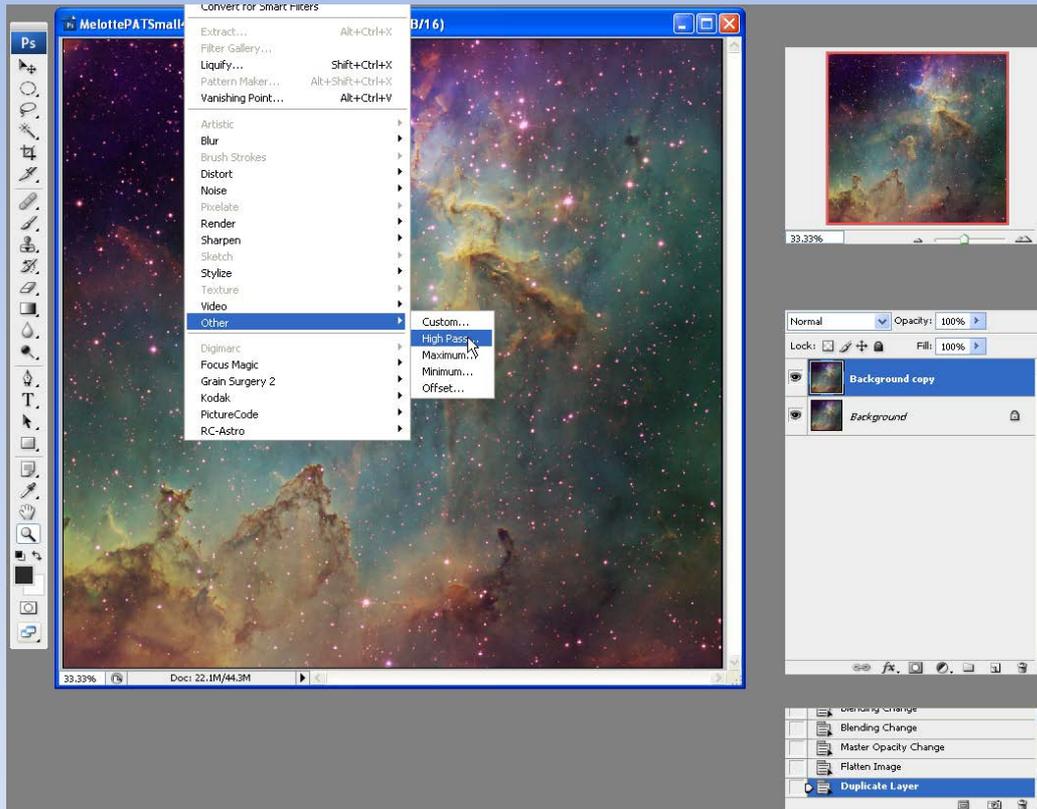
Fine High Pass (5-9 pixels) to bring out fine structure (e.g., filaments)

High Pass Filtering in Photoshop



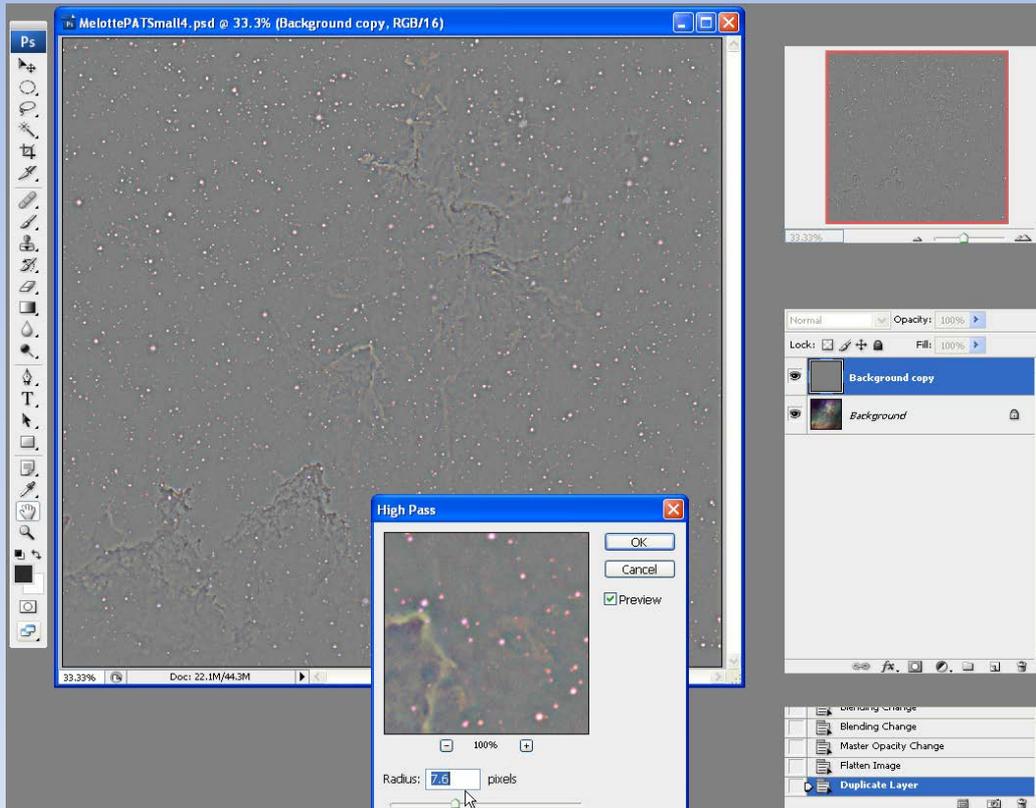
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High Pass Filtering in Photoshop



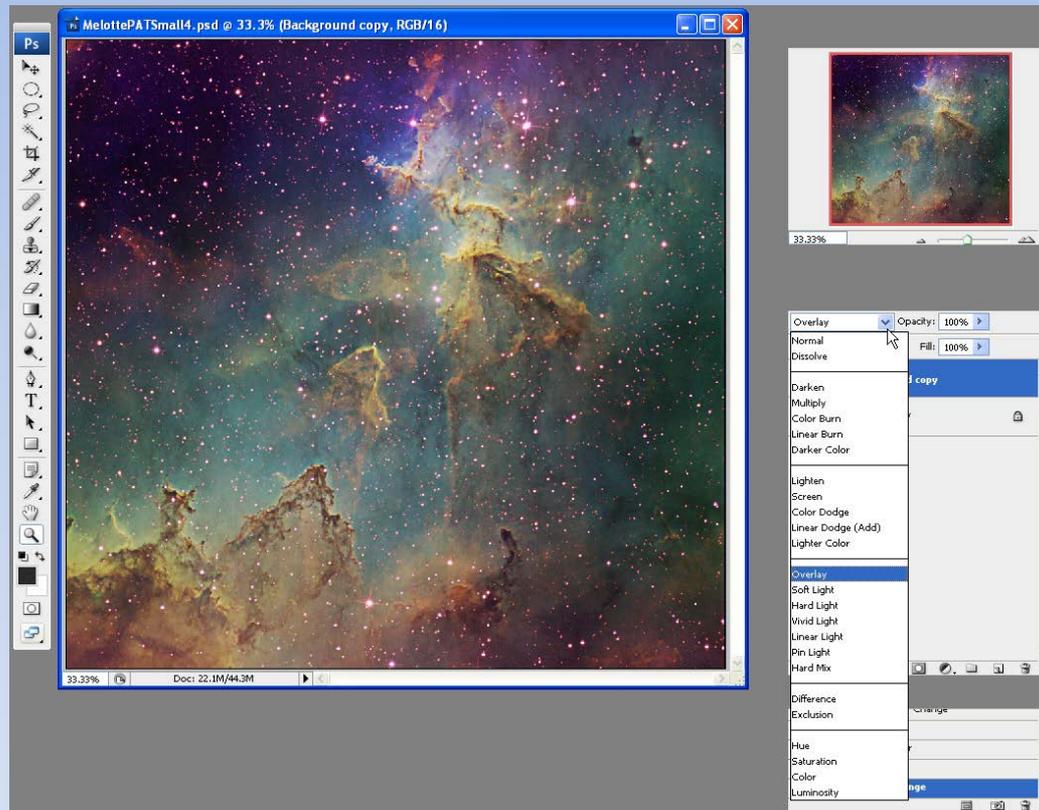
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High Pass Filtering in Photoshop



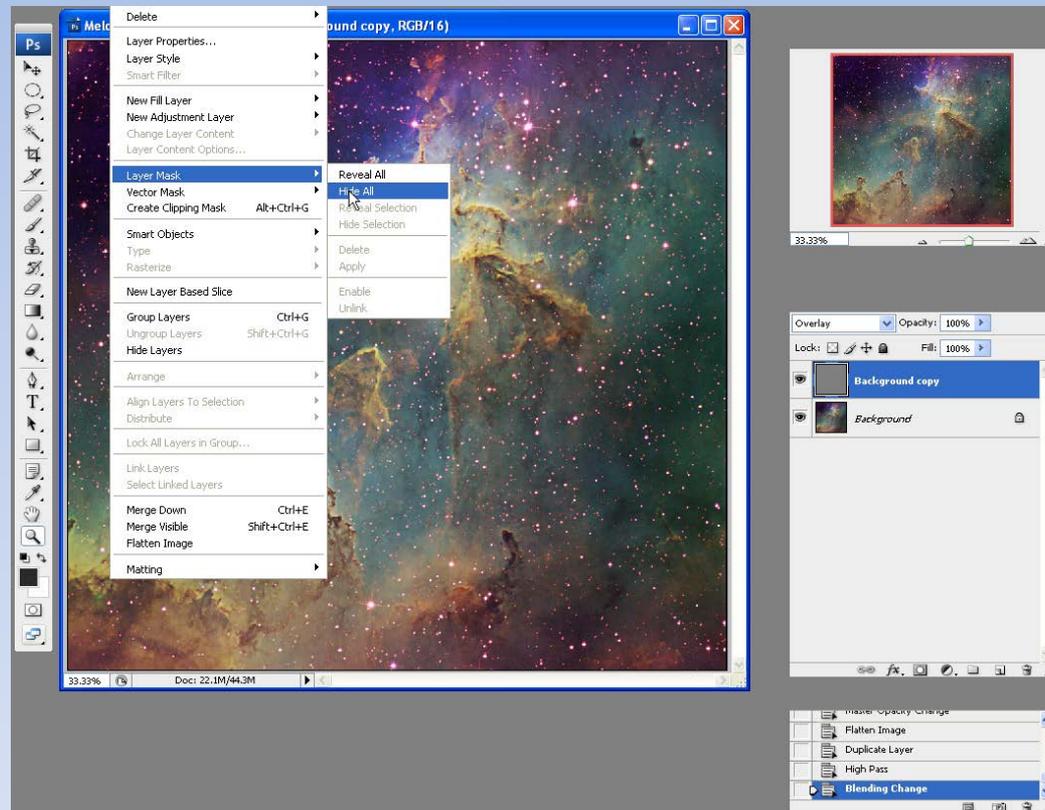
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High Pass Filtering in Photoshop



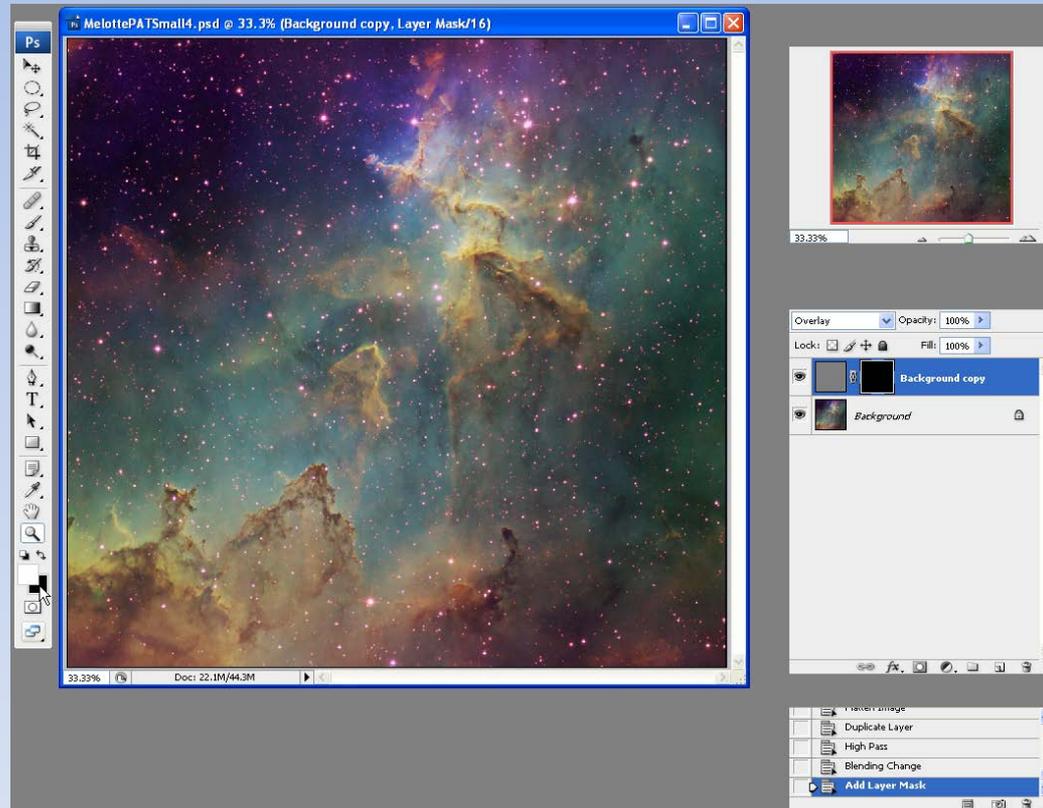
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High Pass Filtering in Photoshop



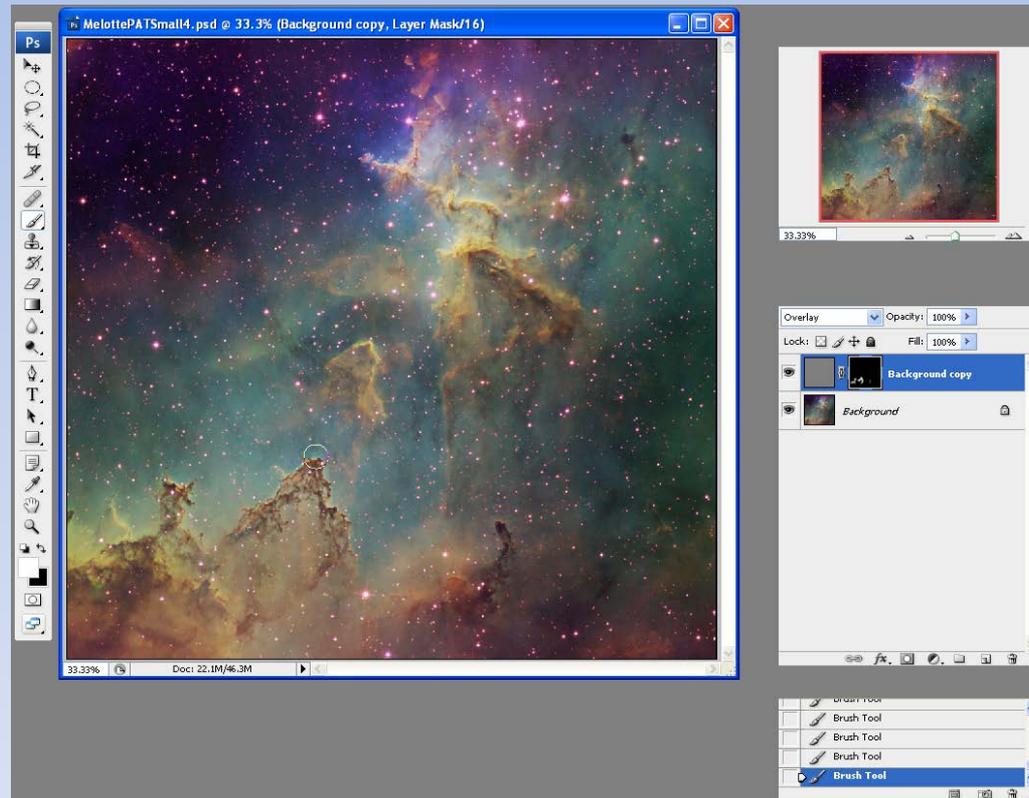
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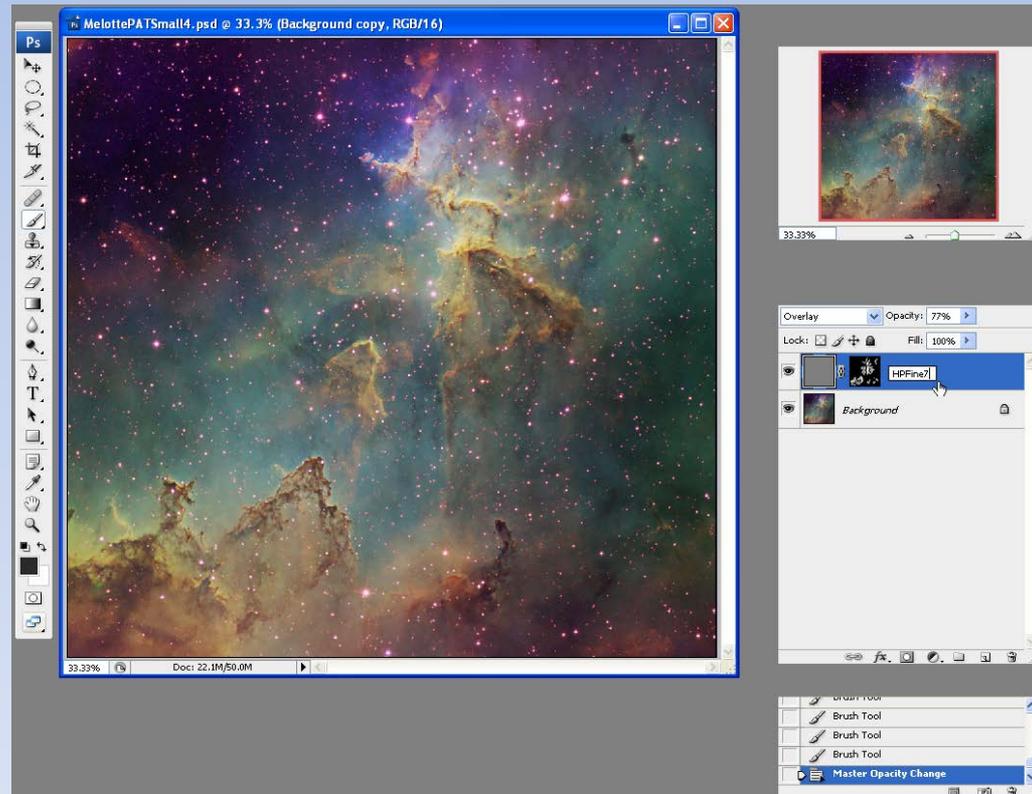
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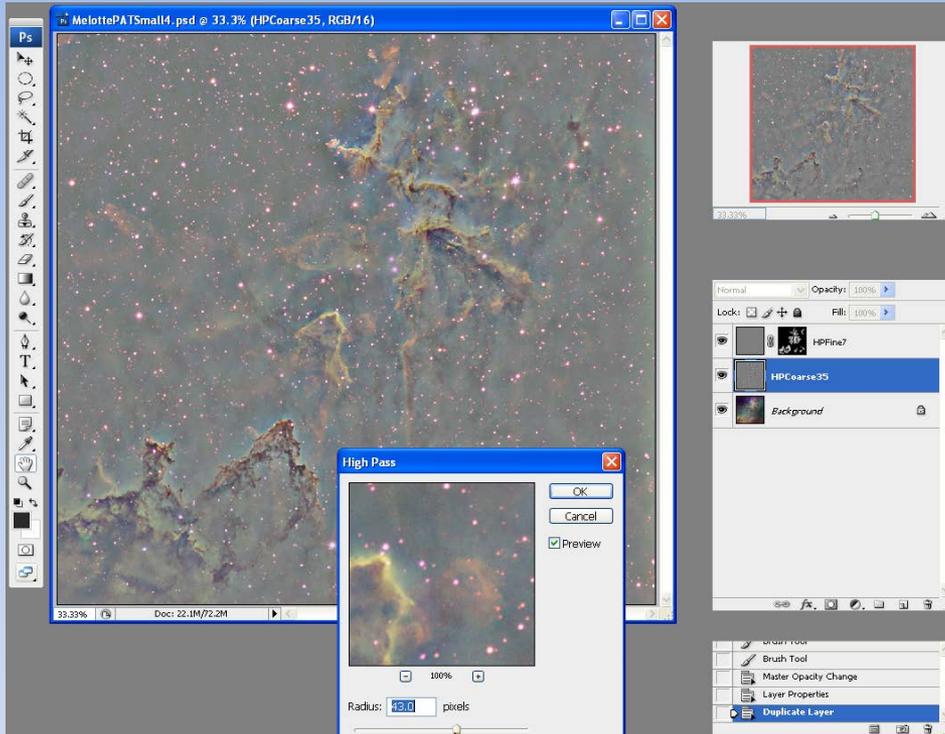
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High Pass Filtering in Photoshop

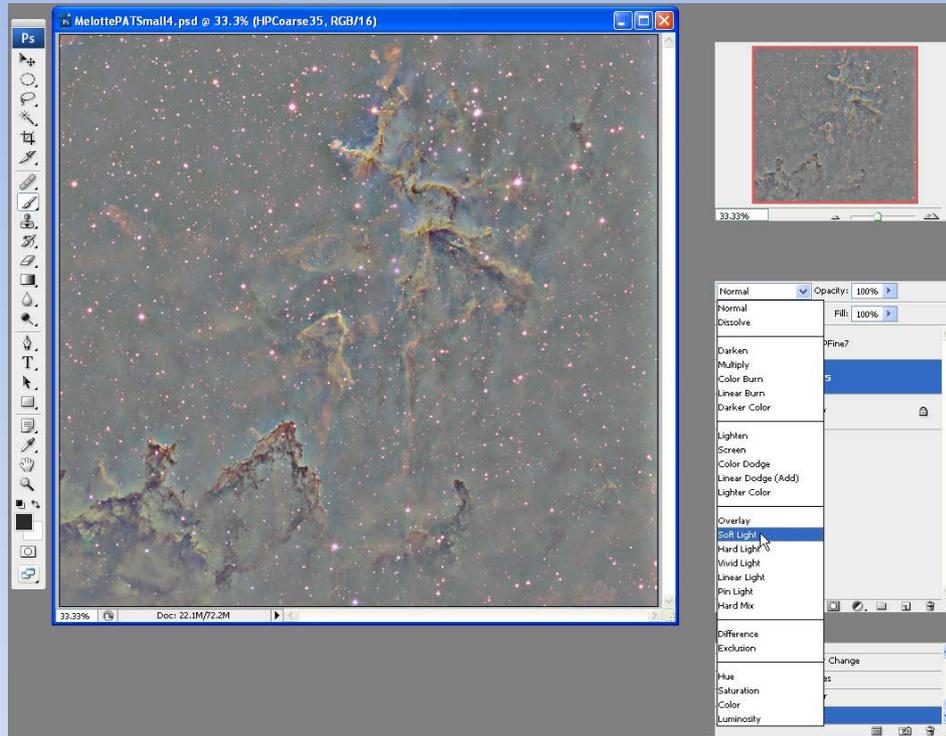


Fine High Pass (5-9 pixels) to bring out fine structure (e.g., filaments)

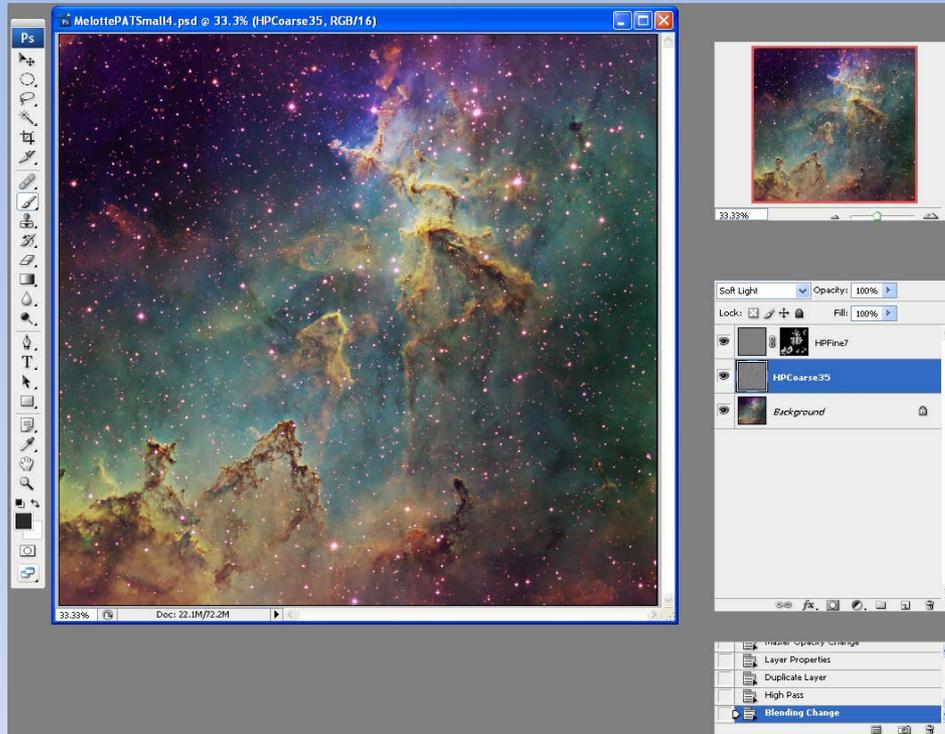
Coarse High Pass for 3-D



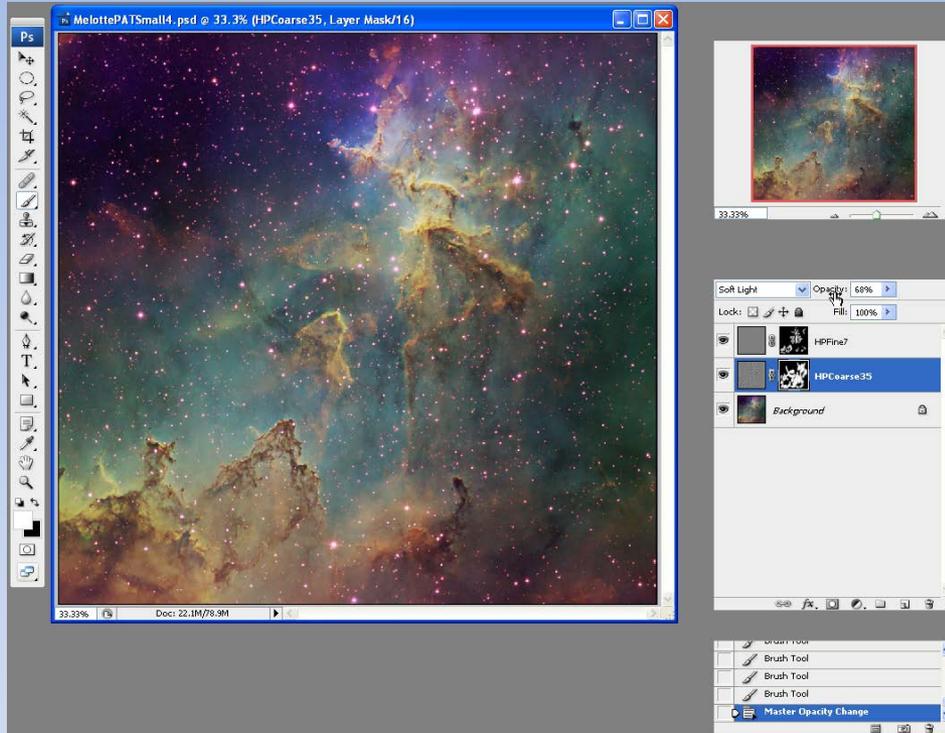
Coarse High Pass for 3-D



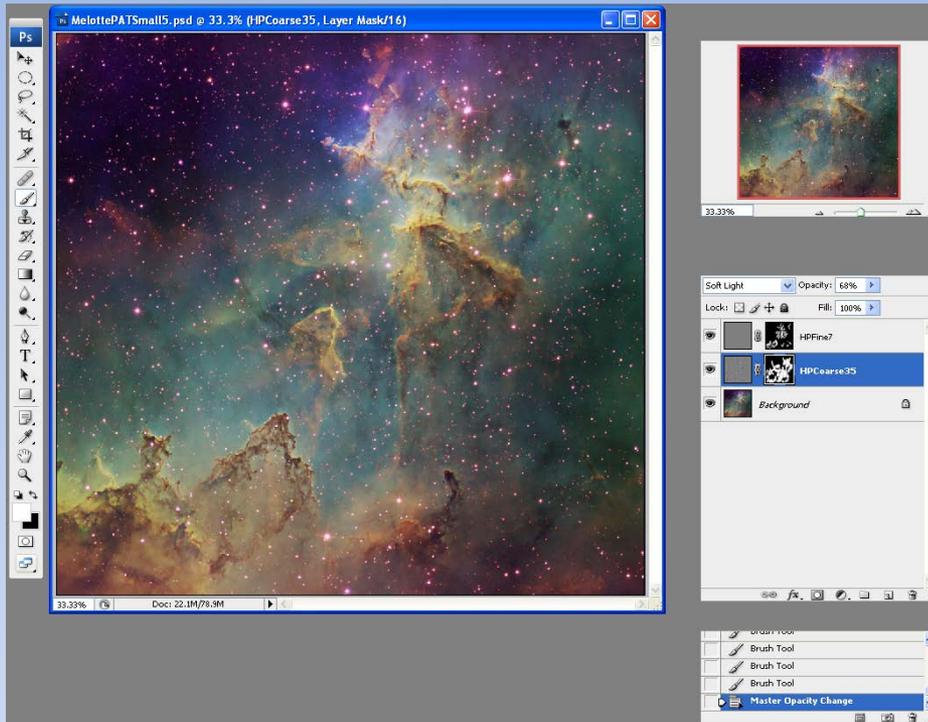
Coarse High Pass for 3-D



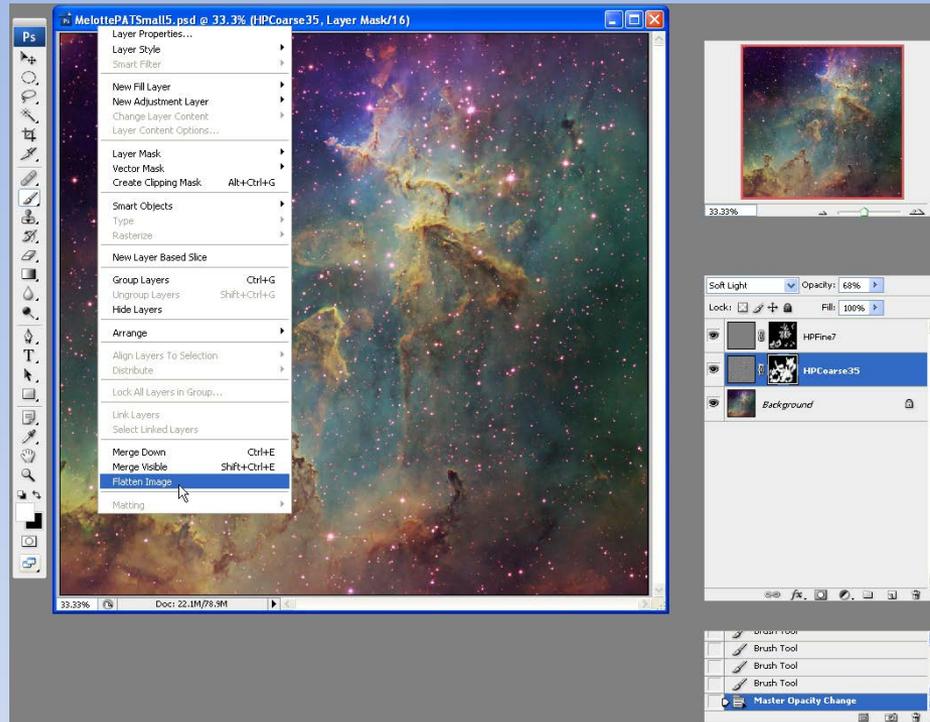
Coarse High Pass for 3-D



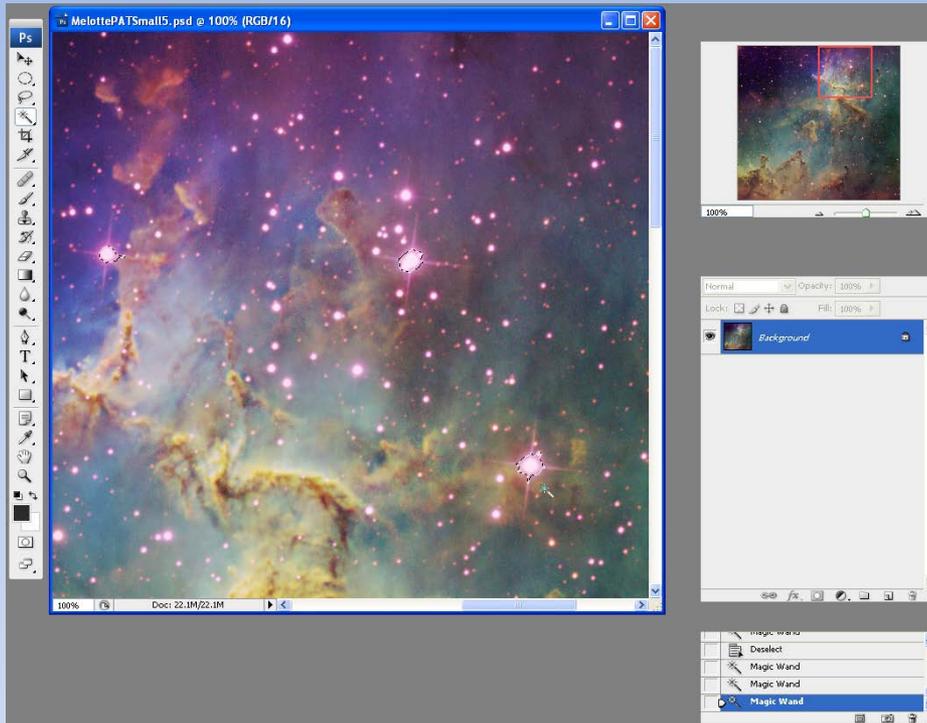
Magenta Star Cleanup



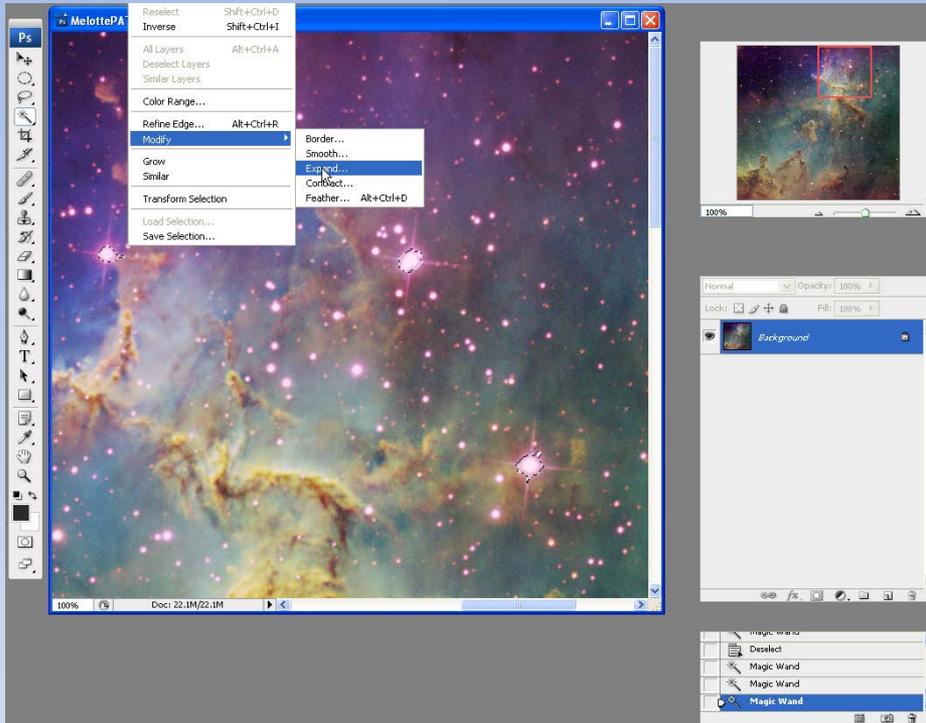
Magenta Star Cleanup



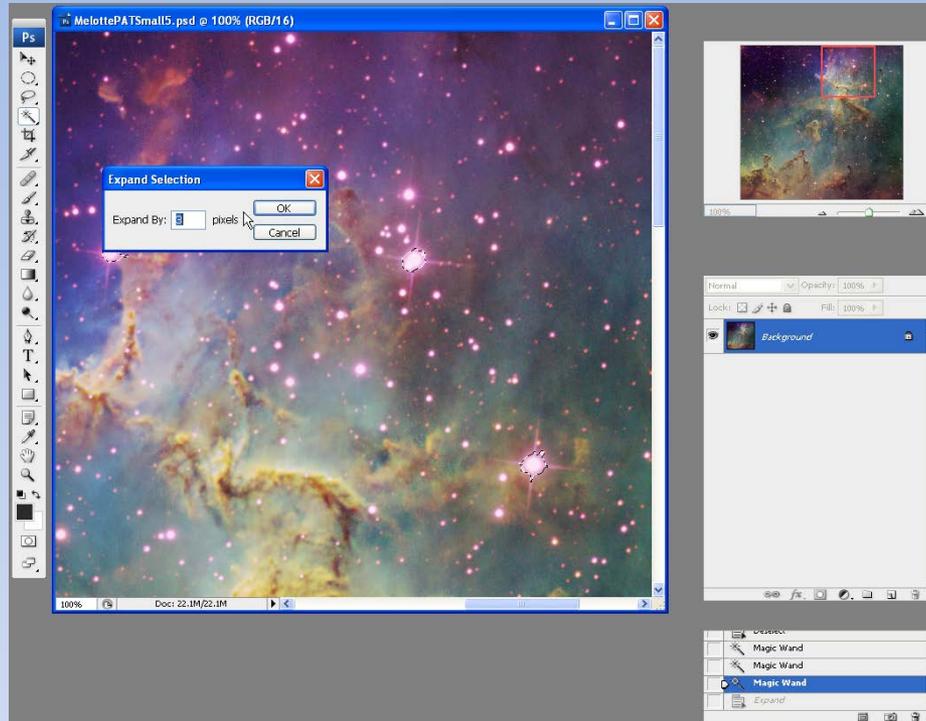
Magenta Star Cleanup



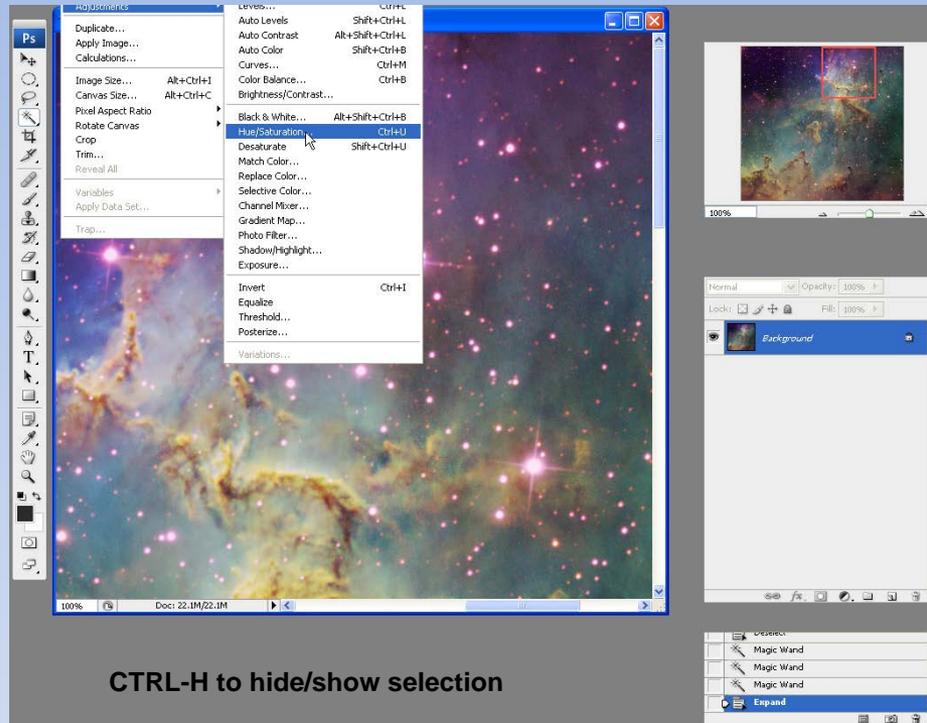
Magenta Star Cleanup



Magenta Star Cleanup

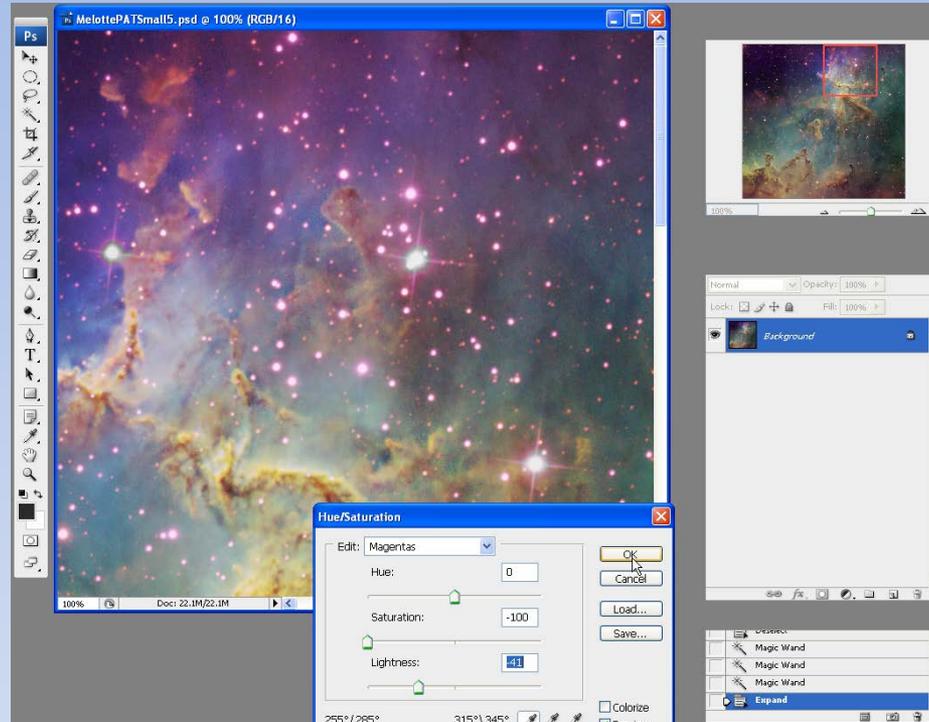


Magenta Star Cleanup

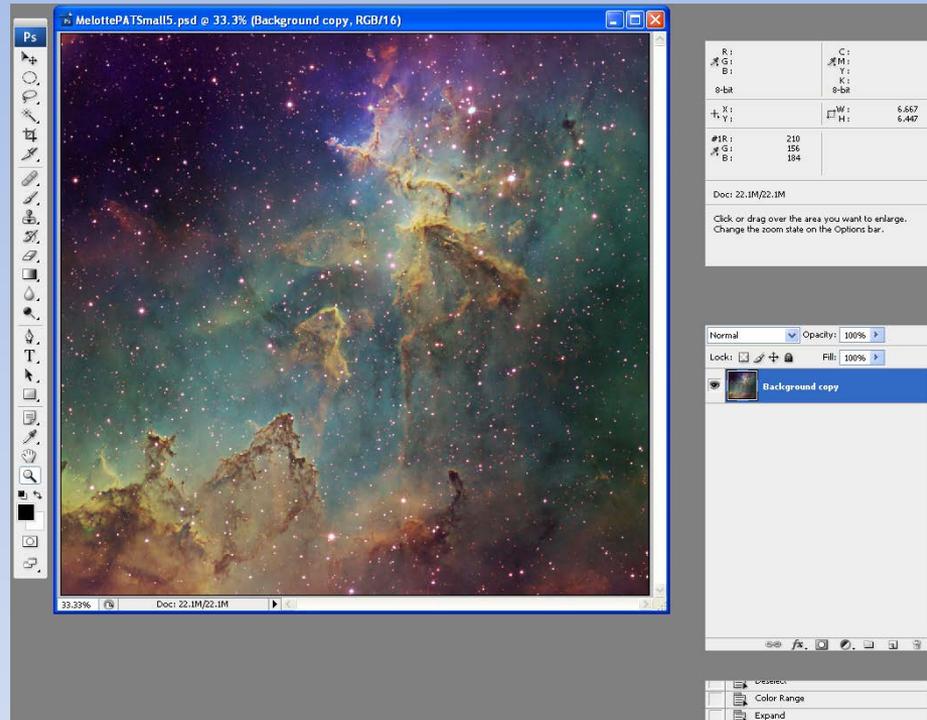


CTRL-H to hide/show selection

Magenta Star Cleanup

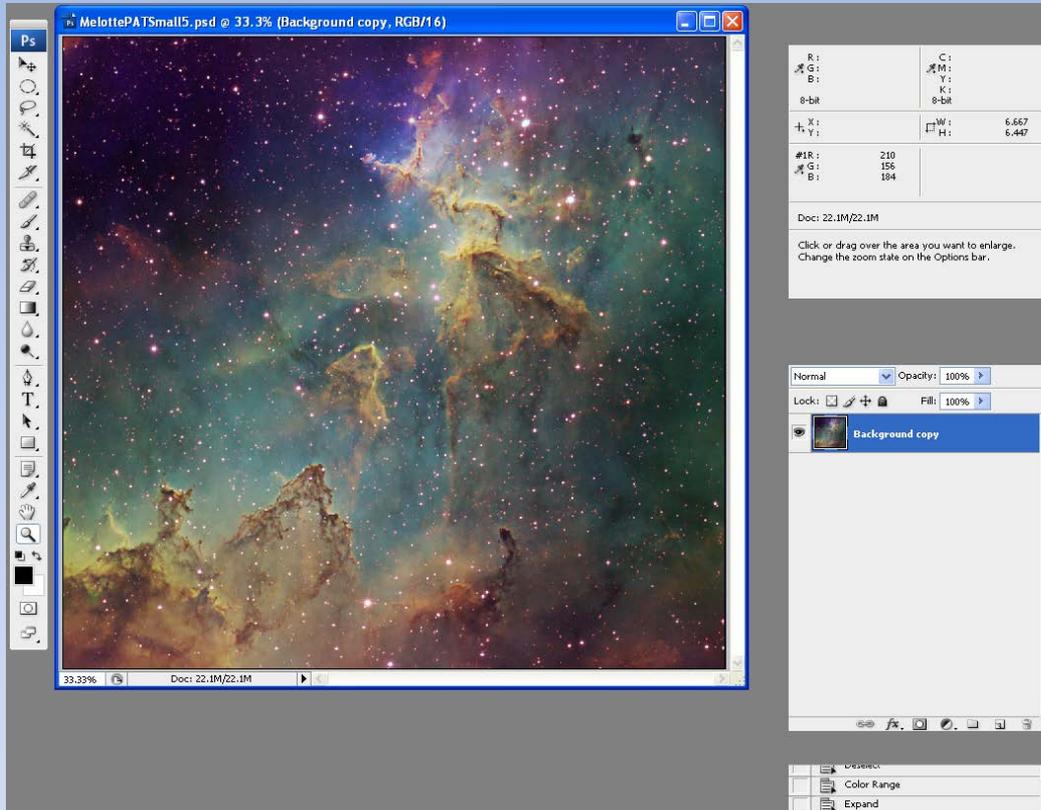


Magenta Star Cleanup

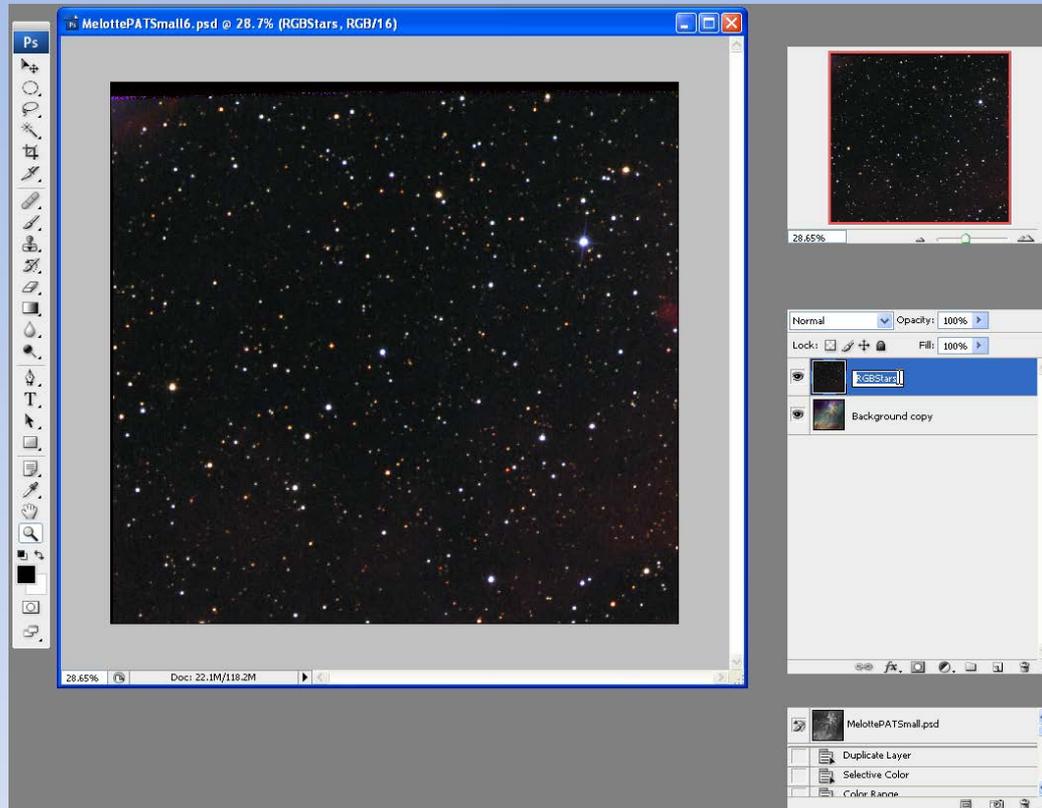


- Select stars with magic wand and SHIFT+ magic wand, or
- (Select/Color Range/Highlights) and then deselect any bright nebular areas captured (ALT+lasso)
- Image/Adjustment/Selective Color, select white and slide the magenta slider to the left... cleans up magenta in central parts of stars
- Don't forget to deselect stars (CTRL-D)

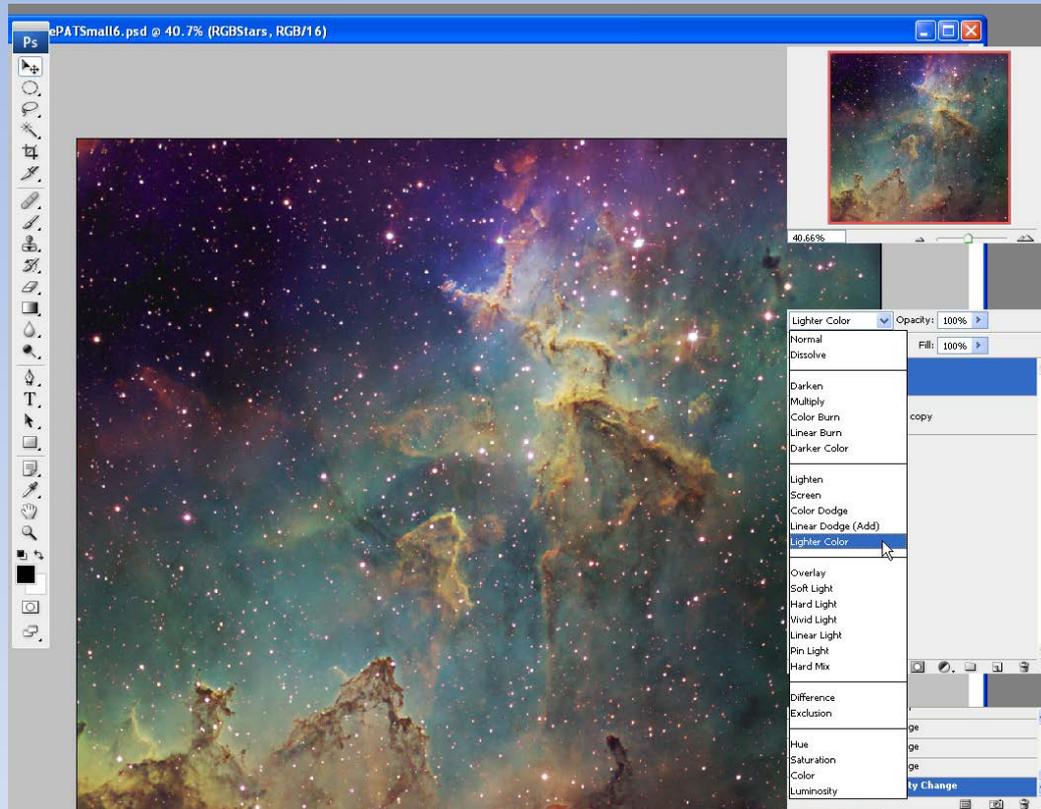
Adding RGB Stars



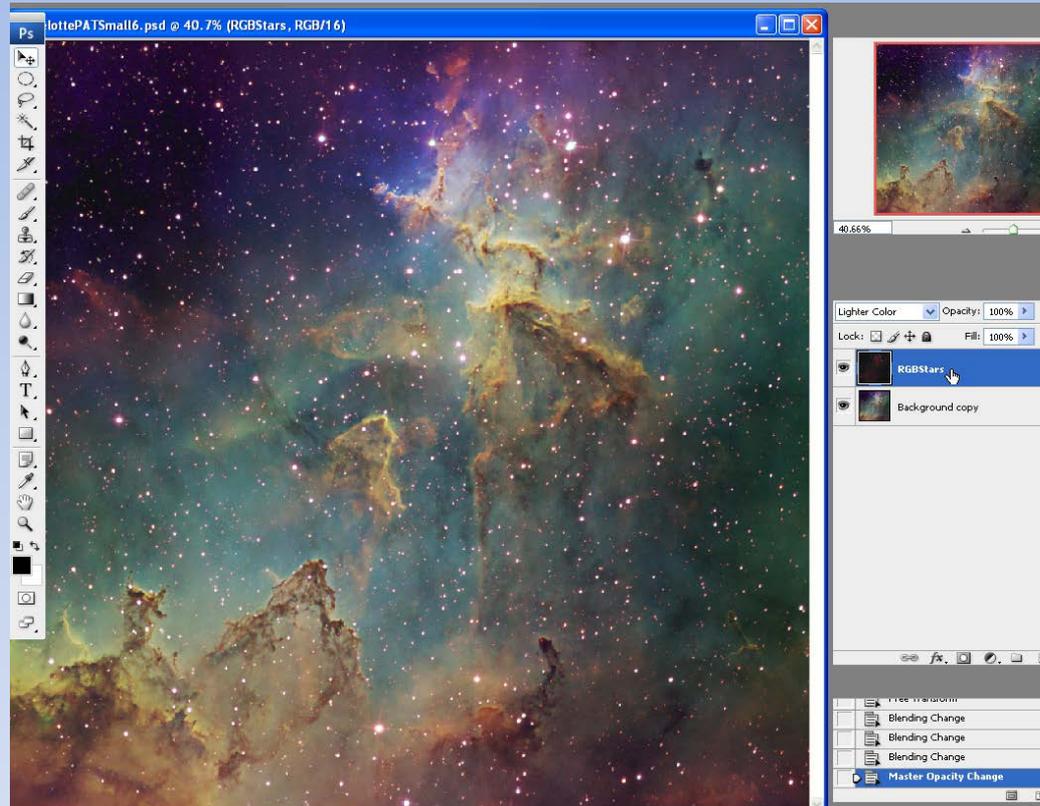
Adding RGB Stars



Adding RGB Stars



Adding RGB Stars



Review

- What is narrowband imaging?
- Narrowband filters
- Benefits
- Mapped color using clipping layer masks
- Luminance layer
- High pass filtering for 3-D effect
- Magenta star cleanup
- Adding RGB stars
- Questions?

Contact: don@astrodon.com
www.astrodonimaging.com (images, tutorials)



Thank You!!
Clear Skies