

*Focal Pointe Observatory*

*Bob Franke*



# DSLR Astrophotography



They say... start  
with a joke.





# DLSR Wide-field Astrophotography

## The Advantages

It's Relatively Inexpensive  
All you need is a DLSR camera

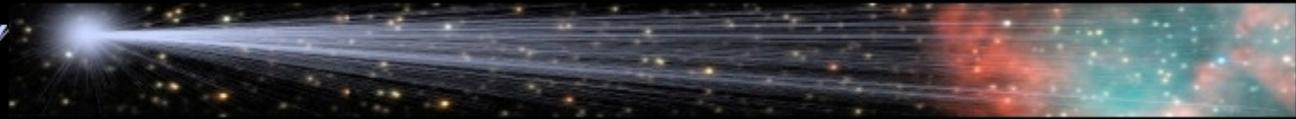




...and a tripod



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# You Don't Need This!



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Nikon

v.s.

Canon



Most DSLR astrophotographers use Canon cameras.

Canon releases the details of the camera's software.

This allows the development of third party software, designed specifically for astrophotography.

Nikon does not create a truly raw image

A simple median blurring filter is always applied... removing many stars, as they are seen as noise.

This prohibits precise image calibration.

Some Nikons allow the "Mode 3" work around.



## Using Nikon's Mode 3

Simply start the bulb time exposure and terminate it by turning off the camera.

The camera sees this as a low-power warning and immediately saves the image without running the median blurring filter

### Testing For Mode 3 Availability

Take a one-minute dark exposure in Mode 1. This is a raw image with “no noise reduction” selected.

Take a one-minute Mode 3 dark exposure.

If Mode 3 is available, that exposure will have noticeably more hot pixels and noise.



## For Starters... Keep It Simple

Set the focus to infinity... before it's dark

Mount the camera on a sturdy tripod

Use a wide angle lens (18mm is nice)

Set the lens to its lowest f-stop

Use the RAW image format, at the highest ISO setting

Shoot 20-30 second exposures

Take about five dark exposures (more on this later)

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...and you can  
get an image  
like this!

Nikon D40X

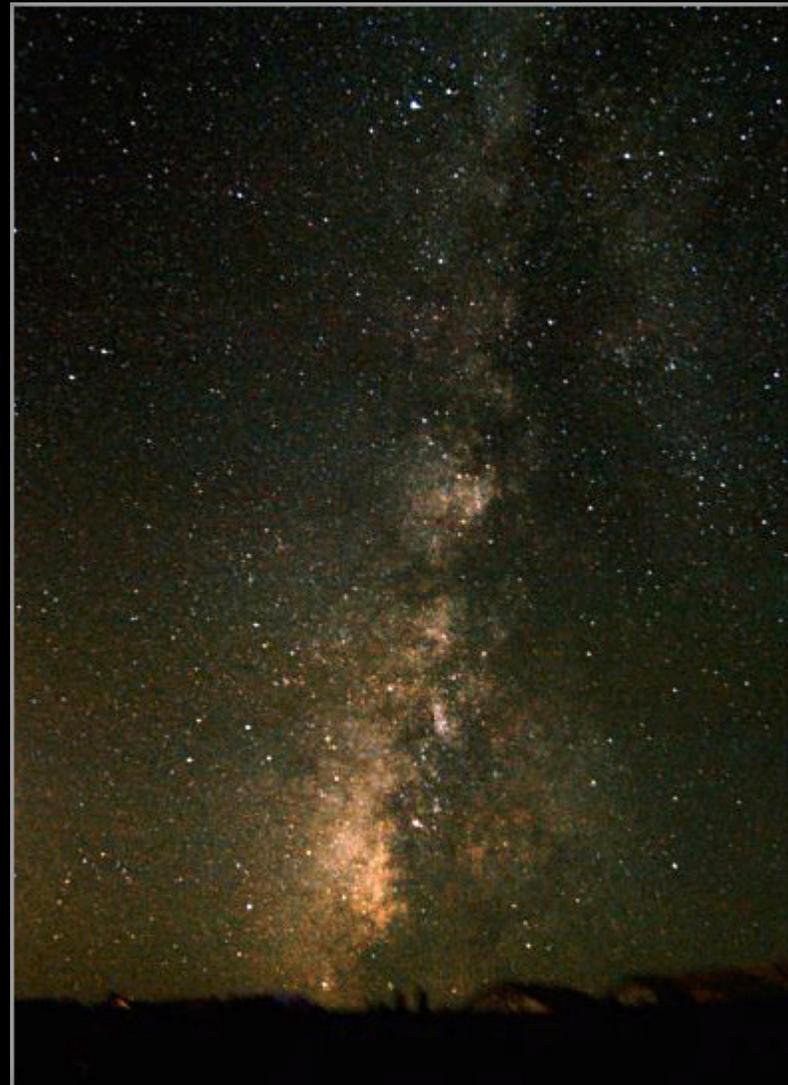
18mm @ f/4

ISO 1600

Mode 1

4 30-Sec exposures

4 30-Sec darks



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After taking several Milky Way shots it may be time to get more adventurous.



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Especially at night!



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However, the  
reward can be great.



© Wally Pacholka - [astropics.com](http://astropics.com)



## The Barn Door Tracker

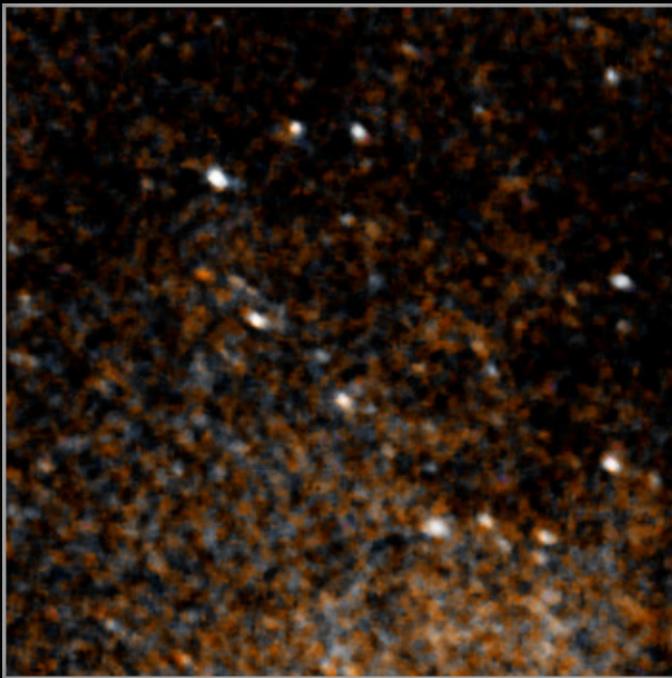
Build cost ~ \$200. Just  
the ball head cost \$50.

A polar alignment scope is  
used for set up. Holding a  
green laser on the pivot  
hinge also works, but look  
out for airplanes.

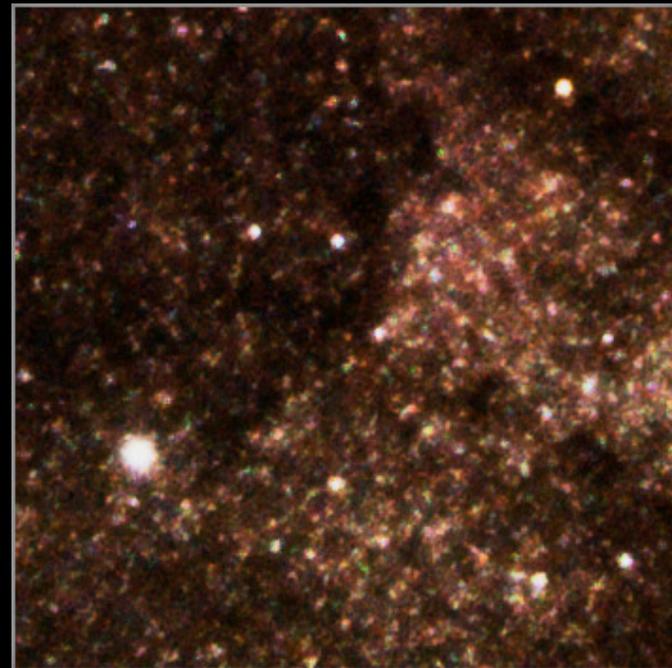




4 30-second exposures  
using a stationary tripod



2 5-minute exposures  
with a Barn Door Tracker

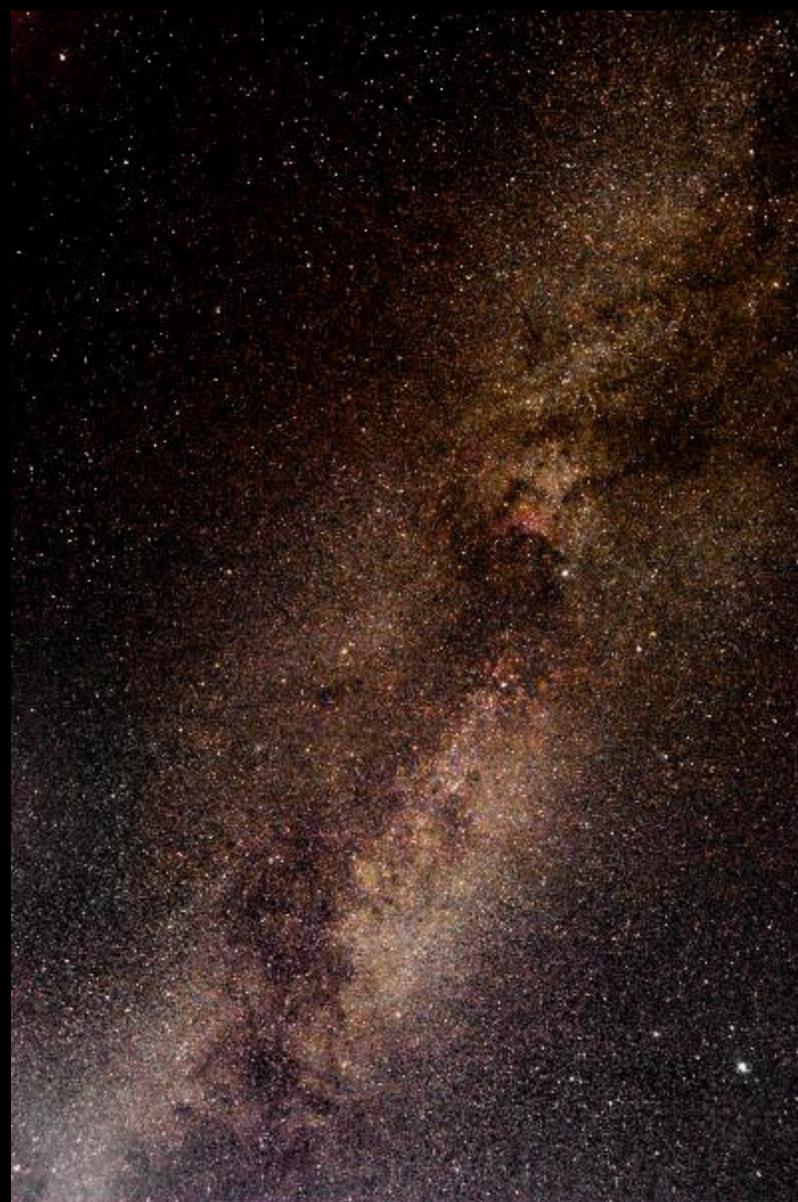


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2 5-minute exposures  
with a Barn Door Tracker



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## Two one-minute exposures w/ Barn Door Tracker



## AstroTrac

This is the ultimate portable camera guider.

Base price is \$600, but will be ~ \$1000 with accessories.

It tracks for about two hours and takes about 90 seconds to rewind.



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## AstroTrac Guided

Canon EOS 1000D (ISO 400)  
12mm f/5.6  
18 5-minute exposures

Shown enlarged to 150%,  
reveals excellent star shapes  
and color.

© Bernhard Hubl



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## AstroTrac Guided - Canon 200mm f/2.8 7x5 min exposures



© Richard Taylor



## Using a Modified Camera

DSLR CCD chips are very sensitive to infrared light. This requires installing an IR filter over the chip.

Unfortunately this also filters out the Ha data that is so important for emission nebula images.

The solution... **Remove the filter!**

If you are skilled, there are several web sites with instructions to do it yourself.

Astro Hutch is one source for new modified Canon's, starting at \$1100... including a 12-month warranty.

Filters are available so the camera can still be used for daylight photography.

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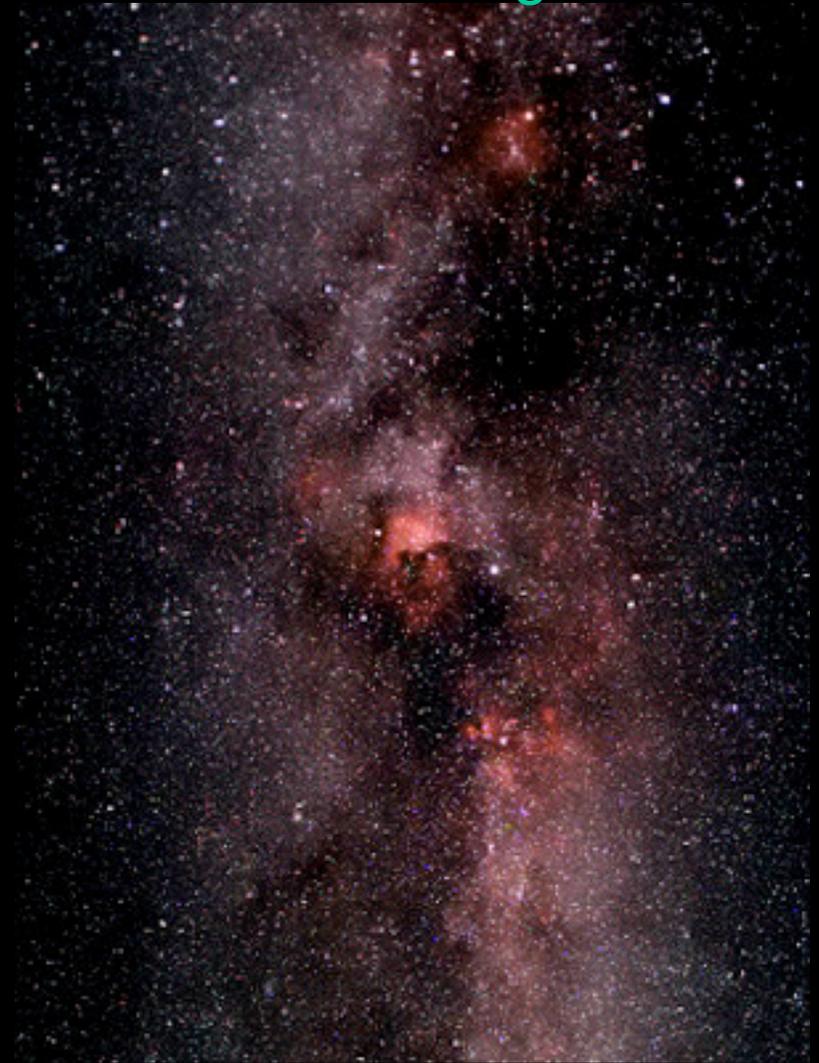
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Unmodified Canon  
© Bernhard Hubl



Modified Canon  
© Brian Morganti





## Fixed Tripod Wide-Field Images

Use a fast 18-25mm lens. Fixed lenses are still better than zooms... except for maybe Nikon's \$1800 14-24mm

Quality wide angle lenses start at about \$800 and are worth it if you are going to get serious with starscapes.

For starscapes, use a high ISO, the widest lens opening and a single 30-60 second exposure.

For star fields, use a bit lower ISO, close the lens one f-stop and take multiple 20-30 second exposures.



## Barn Door and High Quality Tracker Images

With a DIY tracker, use a maximum FL of 50mm. With a high quality commercial tracker, use up to 200mm lenses.

Close the lens one or two f-stops and use an ISO setting of 400 or 800.

Take multiple two to five minute exposures, depending on the quality of your tracking device.



## About Dark Frames

Darks are taken with the lens tightly covered. This produces an image of the camera's noise and hot pixels.

During processing, the dark frame is subtracted from the light frame. This removes the hot pixels and inherent camera noise.

Set the time and ISO to match the light images.

Keep the camera at about the same ambient temperature as the light images.

Take at least as many darks as lights, the more... the better.



Now that we have our light and dark frames, we can process the image.

The rest of the presentation shows the processing steps... using three freeware programs.

Deep Sky Stacker (DSS)

IRIS

GIMP



## Start DSS and open the picture and dark files.

DeepSkyStacker 3.3.2

**Registering and Stacking**

- Open picture files...
- dark files...
- flat files...
- dark flat files...
- offset/bias files...

Open a File List...  
Save the File List...  
Clear List

Check all  
Check above a threshold...  
Uncheck all

Register checked pictures...  
Compute offsets...  
Stack checked pictures...  
Batch stacking...

Light Frames:4 - Dark Frames: 4 - Flat Frames:0 - Dark Flat Frames: 0 - Offset/Bias Frames:

	Path	File	Type	Score
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0052.NEF	Light	251.8
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0053.NEF	Light	237.0
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0054.NEF	Light	228.4
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0055.NEF	Light	246.0
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0056.NEF	Dark	Nj
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0057.NEF	Dark	Nj
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0058.NEF	Dark	Nj
<input checked="" type="checkbox"/>	C:\_MyData\Astro\mWay1\	DSC_0059.NEF	Dark	Nj

Click *Register checked pictures*.

DeepSkyStacker 3.3.2

**Registering and Stacking**

- Open picture files...
  - dark files...
  - flat files...
  - dark flat files...
  - offset/bias files...
- Open a File List...
- Save the File List...
- Clear List
- Check all
- Check above a threshold...
- Uncheck all
- Register checked pictures...**
- Compute offsets...
- Stack checked pictures...
- Batch stacking...

**Processing**

- Open picture file...

**Register Settings**

Actions | **Advanced**

- Register already registered pictures
- Automatic detection of hot pixels
- Stack after registering

Select the best  % pictures and stack them.

Don't forget to add and check flat and offset frames before stacking.

Recommended Settings... Cancel

Stacking parameters... OK

Flat Frames: 0 - Offset/Bias Frames: 0

	Type	Score
F	Light	251.83
F	Light	237.09
F	Light	228.47
F	Light	246.09
F	Dark	N/A

## Set the star detection threshold.

The screenshot shows the DeepSkyStacker 3.3.2 interface. A "Register Settings" dialog box is open, displaying the "Advanced" tab. The "Star detection threshold" is set to 37% on a slider. Below the slider is a button labeled "Compute the number of detected stars" which shows "37 star(s)". A checkbox for "Reduce the noise by using a Median Filter" is checked. The background shows the "Registering and Stacking" sidebar and a file list table.

Type	Score
Light	NC
Dark	N/A

Click on *Stacking parameters*.

DeepSkyStacker 3.3.2

Registering and Stacking

- Open picture files...
  - dark files...
  - flat files...
  - dark flat files...
  - offset/bias files...
- Open a File List...
- Save the File List...
- Clear List
- Check all
- Check above a threshold...
- Uncheck all
- Register checked pictures...
- Compute offsets...
- Stack checked pictures...
- Batch stacking...

Processing

- Open picture file...

C:\Temp\stackerUn\New Folder\DSC\_0056.NEF

Register Settings

Actions Advanced

Star detection threshold

37 %

Compute the number of detected stars

37 star(s)

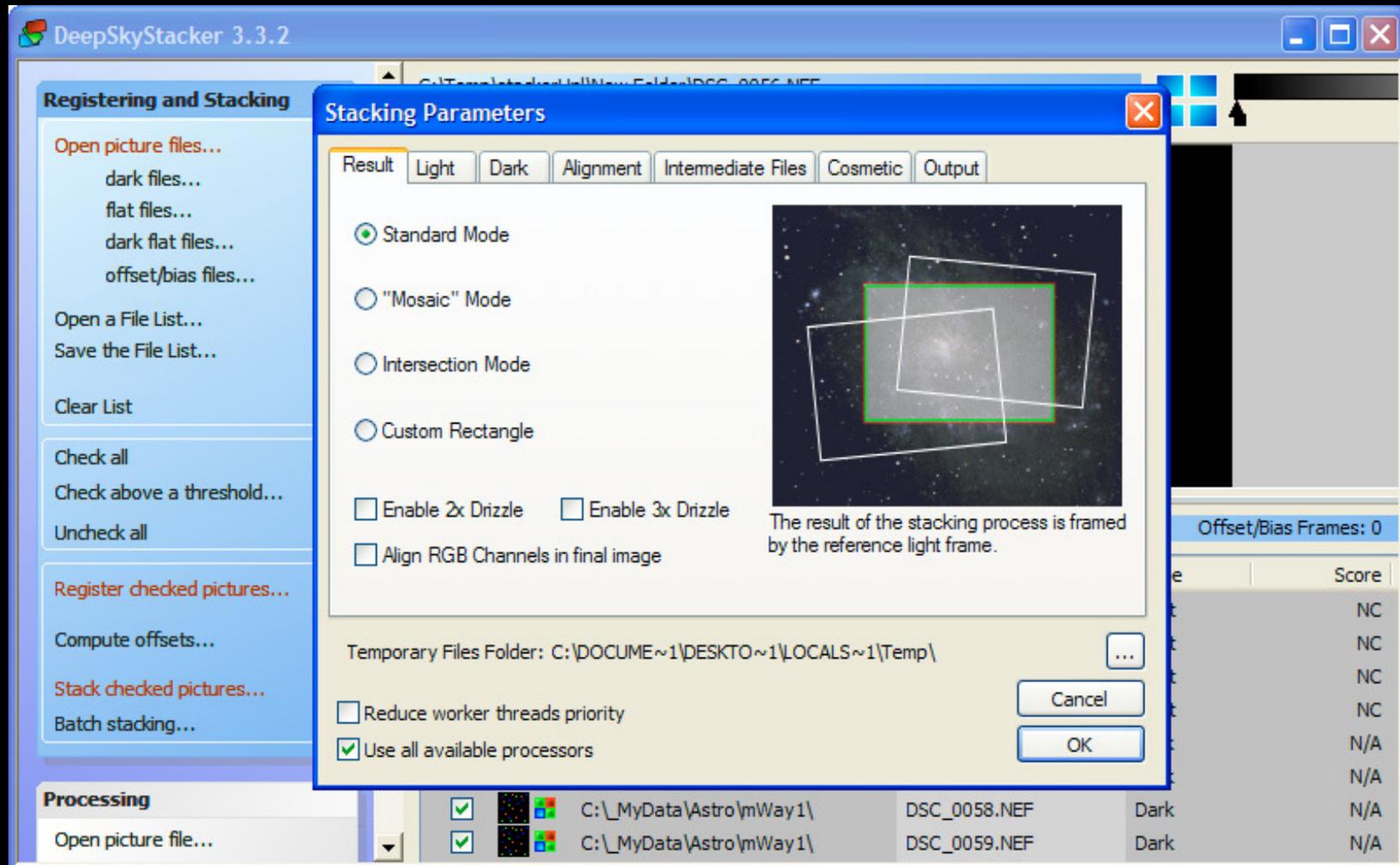
Reduce the noise by using a Median Filter

Recommended Settings... Cancel

**Stacking parameters...** OK

	Type	Score
	Light	NC
	Dark	N/A

## Select the Standard result mode.



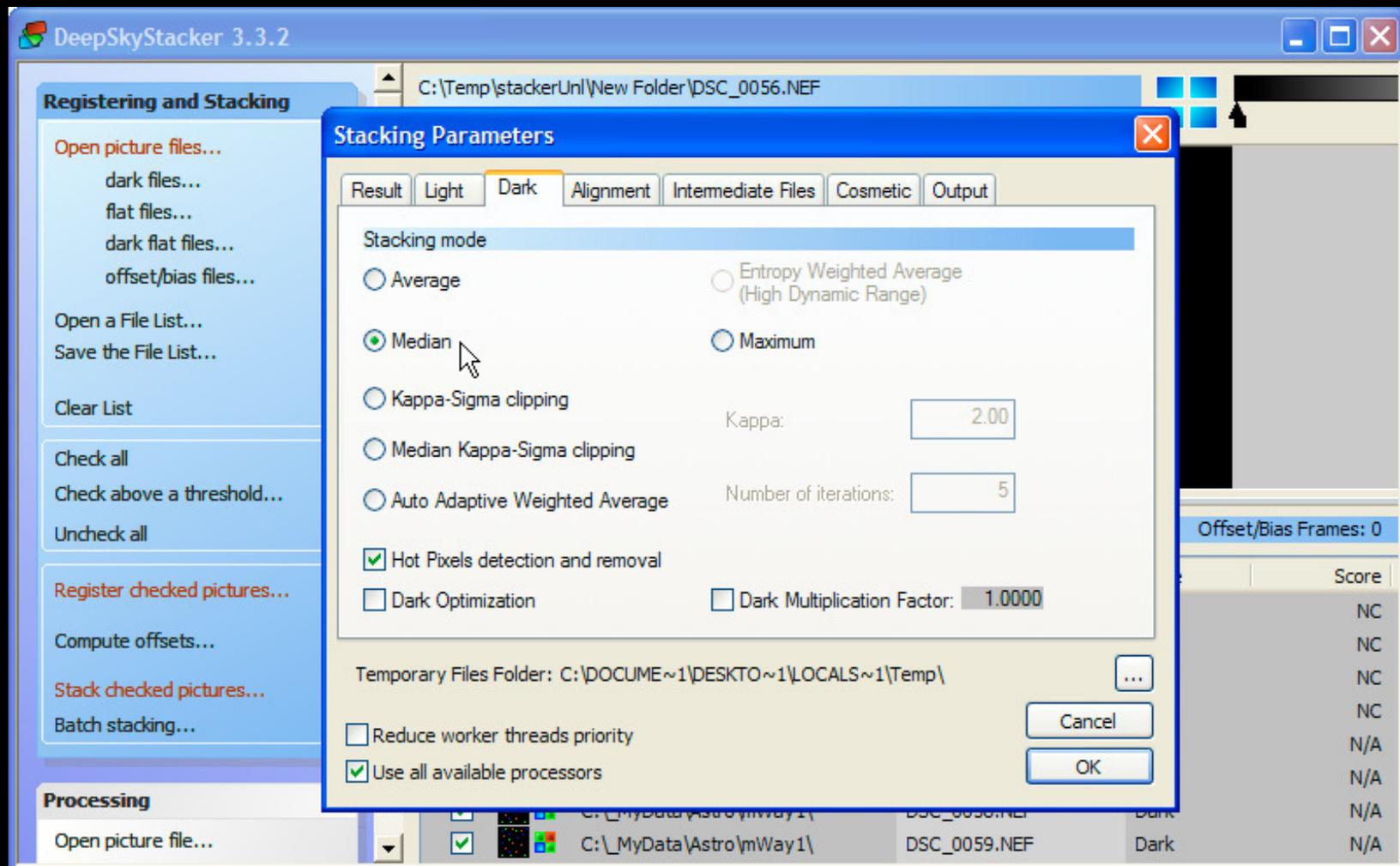
Select the Average stacking mode for lights.

The screenshot shows the DeepSkyStacker 3.3.2 interface. The 'Stacking Parameters' dialog box is open, with the 'Light' tab selected. The 'Stacking mode' section has the 'Average' radio button selected. Other options include 'Entropy Weighted Average (High Dynamic Range)', 'Median', 'Maximum', 'Kappa-Sigma clipping', 'Median Kappa-Sigma clipping', and 'Auto Adaptive Weighted Average'. The 'Kappa' value is set to 2.00 and the 'Number of iterations' is set to 5. The 'Per Channel Background Calibration' section is visible below. The 'Temporary Files Folder' is set to C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\.

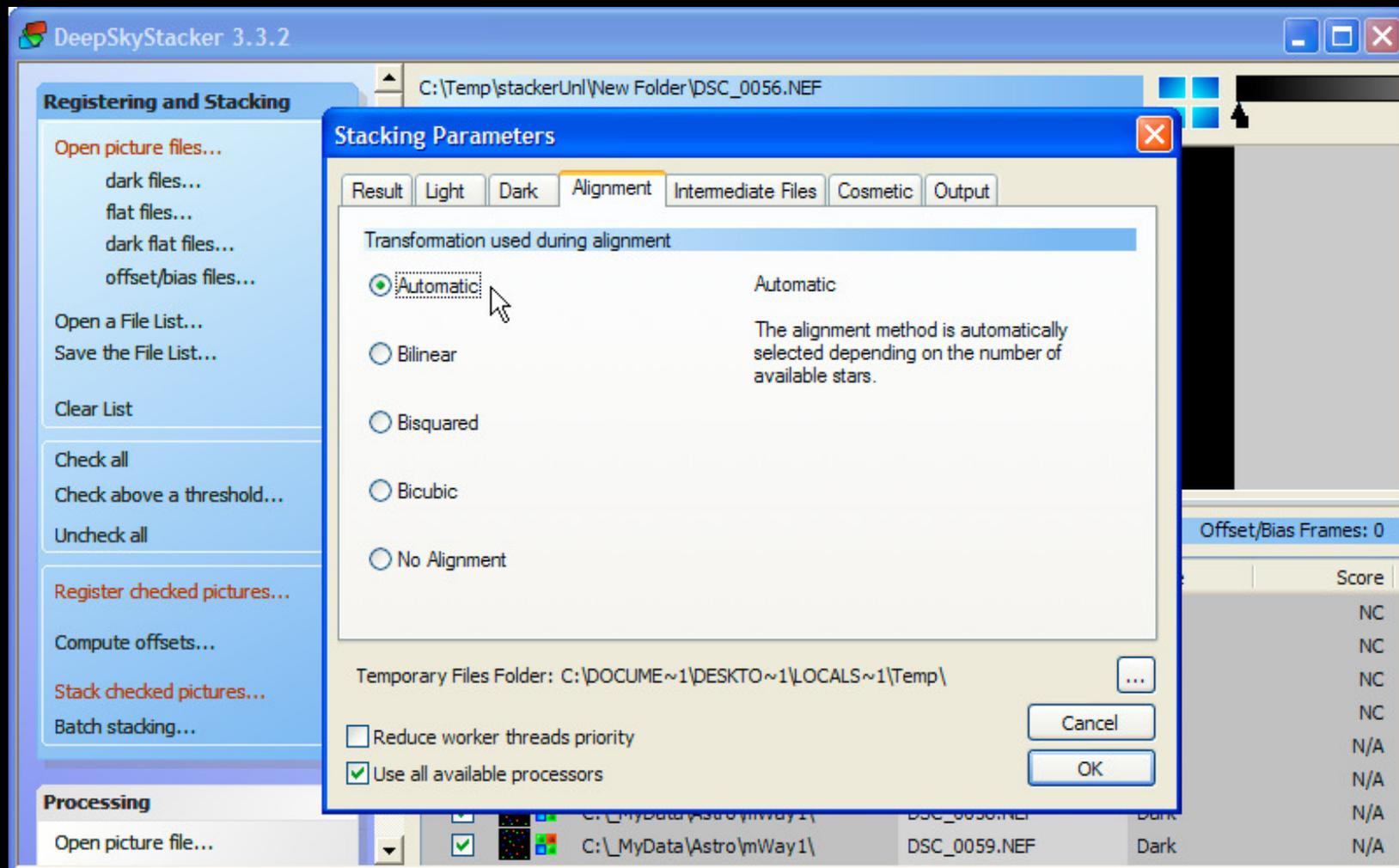
Under the 'Processing' section, a table lists files being processed:

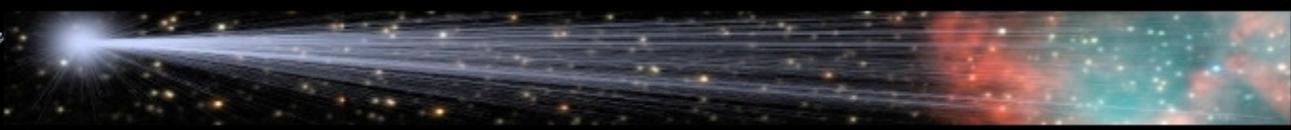
File Name	Type	Score
C:\_MyData\Astro\mWay1\ DSC_0058.NEF	Dark	N/A
C:\_MyData\Astro\mWay1\ DSC_0059.NEF	Dark	N/A

Select the Median stacking mode for darks.

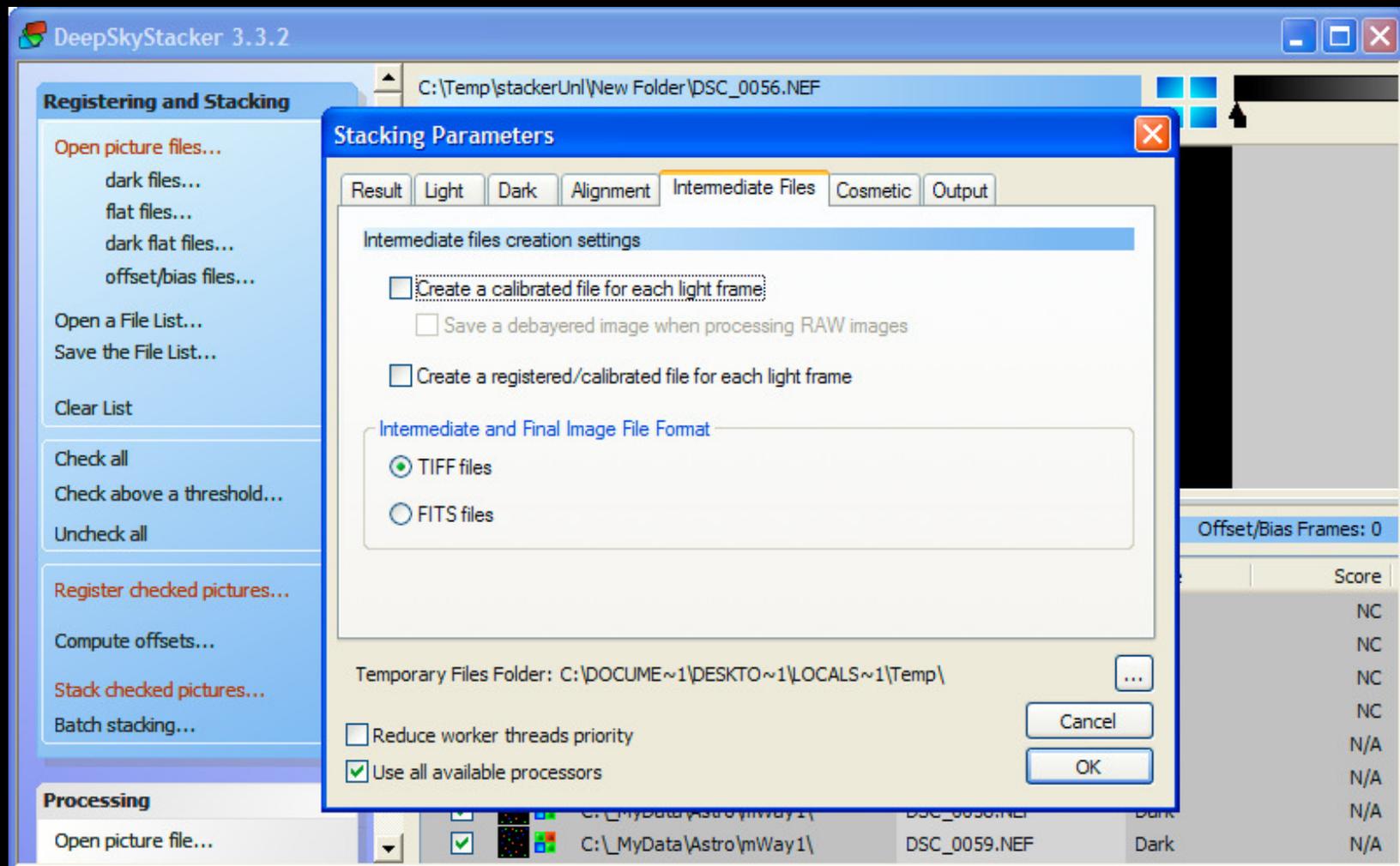


# Select Automatic alignment.

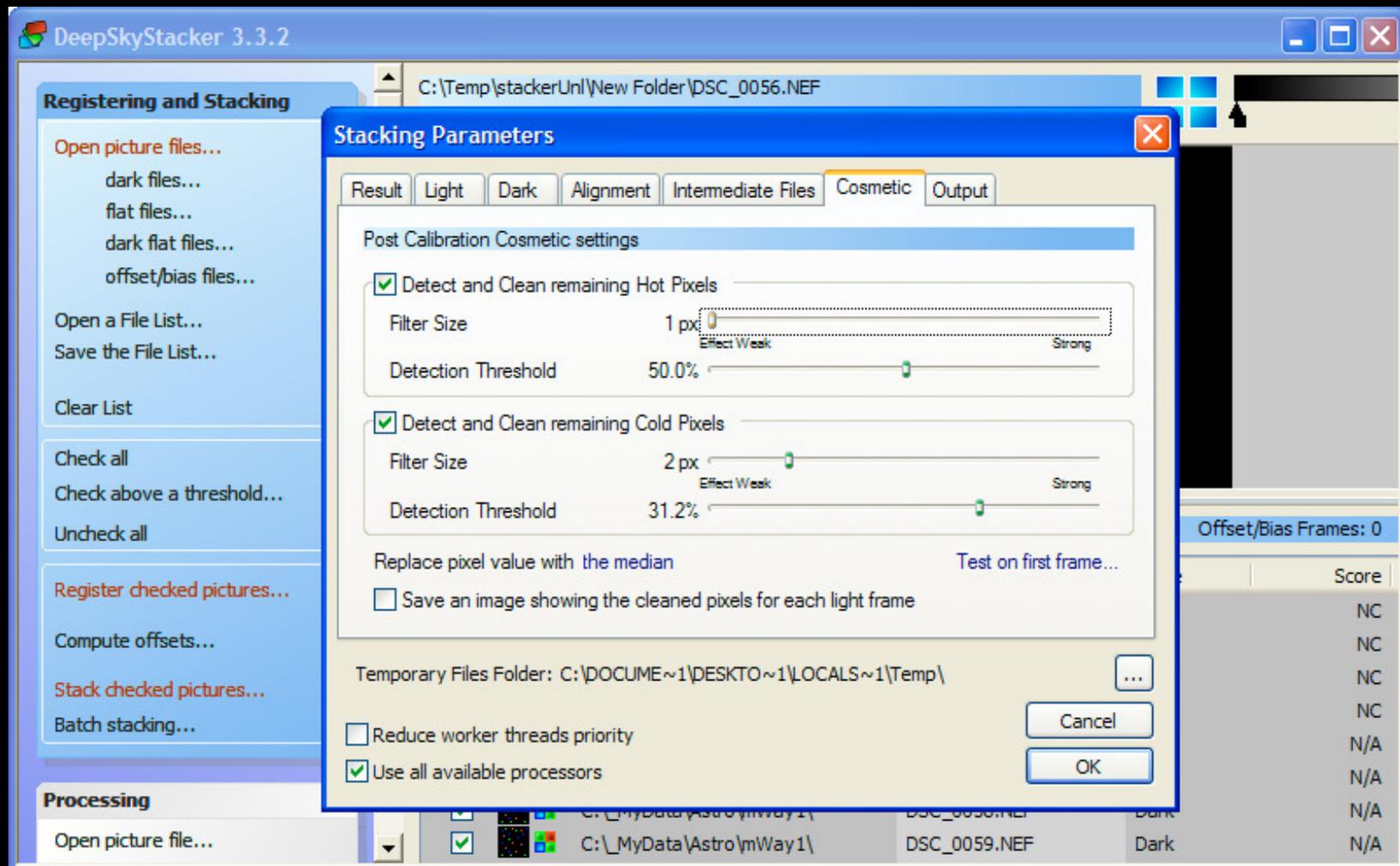




There is usually no need to keep temp files.



This tab will take a bit of experimenting.  
These settings seem to be working OK.



## Finally, set the data for the output files.

The screenshot shows the DeepSkyStacker 3.3.2 interface. The main window title is "DeepSkyStacker 3.3.2" and the current file path is "C:\Temp\stackerUnl\New Folder\DSC\_0056.NEF". The "Stacking Parameters" dialog box is open, with the "Output" tab selected. The "Output Files settings" section includes:

- Create Output file
- Create HTML description file
- Output File Name:  Autosave.tif/fits  <file list name>.tif/fits
- Append a number to avoid file overwrite (001, 002, ...)
- Output Location:  Create Output file in the folder of the reference frame  Create Output file in the folder of the file list  Create Output file in <Output Folder>

The "Temporary Files Folder" is set to "C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\". At the bottom, there are checkboxes for "Reduce worker threads priority" (unchecked) and "Use all available processors" (checked). "Cancel" and "OK" buttons are visible.

In the background, the "Registering and Stacking" panel is visible on the left, and a table of frames is partially visible on the right:

Offset/Bias Frames: 0	Score
	NC
	NC
	NC
	NC
	N/A
	N/A
	N/A
	N/A



Click OK, until you get to this screen.

**Stacking Steps**

Stacking mode: [Standard](#) Alignment method: [Automatic](#)  
4 detected and used processors

[Cosmetic applied to hot pixels \(Filter = 1 px, Detection Threshold = 50.0%\)](#)  
[Cosmetic applied to cold pixels \(Filter = 2 px, Detection Threshold = 31.2%\)](#)

**Stacking step 1**  
->4 frames (ISO: 1600) - total exposure: 1 mn 57 s  
[RGB Channels Background Calibration: No](#)  
[Per Channel Background Calibration: Yes](#)  
Method: [Average](#)

-> No Offset  
-> Dark: 4 frames (ISO : 1600) exposure: 28 s  
Method: [Median](#)  
[Dark optimization: No](#)  
[Hot Pixels detection and removal: Yes](#)  
-> No Flat

**Estimated Total exposure time: 1 mn 57 s**  
(the total exposure time is computed considering that all the checked light frames are kept for the stacking process)

Recommended Settings... Cancel  
Stacking parameters... OK

DeepSkyStacker 3.3.2

Registering and Sta

Open picture files...  
dark files...  
flat files...  
dark flat files...  
offset/bias files

Open a File List...  
Save the File List...  
Clear List

Check all  
Check above a thresh  
Uncheck all

Register checked pictu  
Compute offsets...  
Stack checked picture  
Batch stacking...

Processing

Open picture file...

C:\\_MyData\Astro\mWay1\ DSC\_0059.NEF Dark

Offset/Bias Frames: 0	Score
	NC
	NC
	NC
	NC
	N/A
	N/A
	N/A
	N/A



Click *OK* to start stacking. For this example DSS thrashes around for about two minutes.

**Stacking**

Stacking 4 of 4 - Offset [6.0,-11.1] - Angle : -0.2°  
Saving Final image in C:\\_MyData\Astro\mWay1\Autosave.tif

Estimated remaining time: 14 s

Stop

DeepSkyStacker 3.3.2

C:\Temp\stackerUnl\New Folder\DSC\_0056.NEF

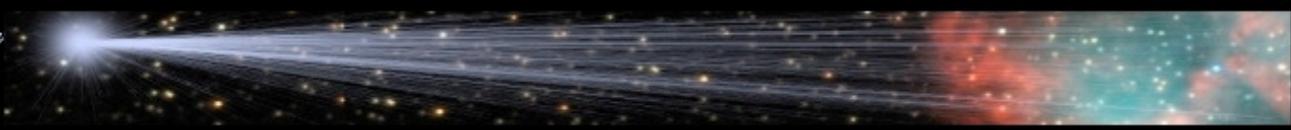
**Registering and Stacking**

- Open picture files...
  - dark files...
  - flat files...
  - dark flat files...
  - offset/bias files...
- Open a File List...
- Save the File List...
- Clear List
- Check all
- Check above a threshold
- Uncheck all
- Register checked pictures...
- Compute offsets...
- Stack checked pictures...
- Batch stacking...

**Processing**

- Open picture file...

Checked	Thumbnail	File Name	Type	Score
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0052.NEF	Light	251.83
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0053.NEF	Light	237.09
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0054.NEF	Light	228.47
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0055.NEF	Light	246.09
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0056.NEF	Dark	N/A
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0057.NEF	Dark	N/A
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0058.NEF	Dark	N/A
<input checked="" type="checkbox"/>		C:\_MyData\Astro\mWay1\DSC_0059.NEF	Dark	N/A



## The Final Stacked Image

DeepSkyStacker 3.3.2

C:\\_MyData\Astro\mWay1\Autosave.tif  
1600 ISO - Exposure: 1 mn 58 s (4 frames)

**Registering and Stacking**

- Open picture files...
  - dark files...
  - flat files...
  - dark flat files...
  - offset/bias files...
- Open a File List...
- Save the File List...
- Clear List
- Check all
- Check above a threshold...
- Uncheck all
- Register checked pictures...
- Compute offsets...
- Stack checked pictures...
- Batch stacking...

**Processing**

- Open picture file...
- Copy current picture to clipboard
- Create a Star Mask...
- Save picture to file...

**Options**

- Settings...
- Raw/FITS DDP Settings...
- Load...
- Save...
- Recommended...
- About DeepSkyStacker...
- DeepSkyStacker's Help...

RGB/K Levels Luminance Saturation

log

log

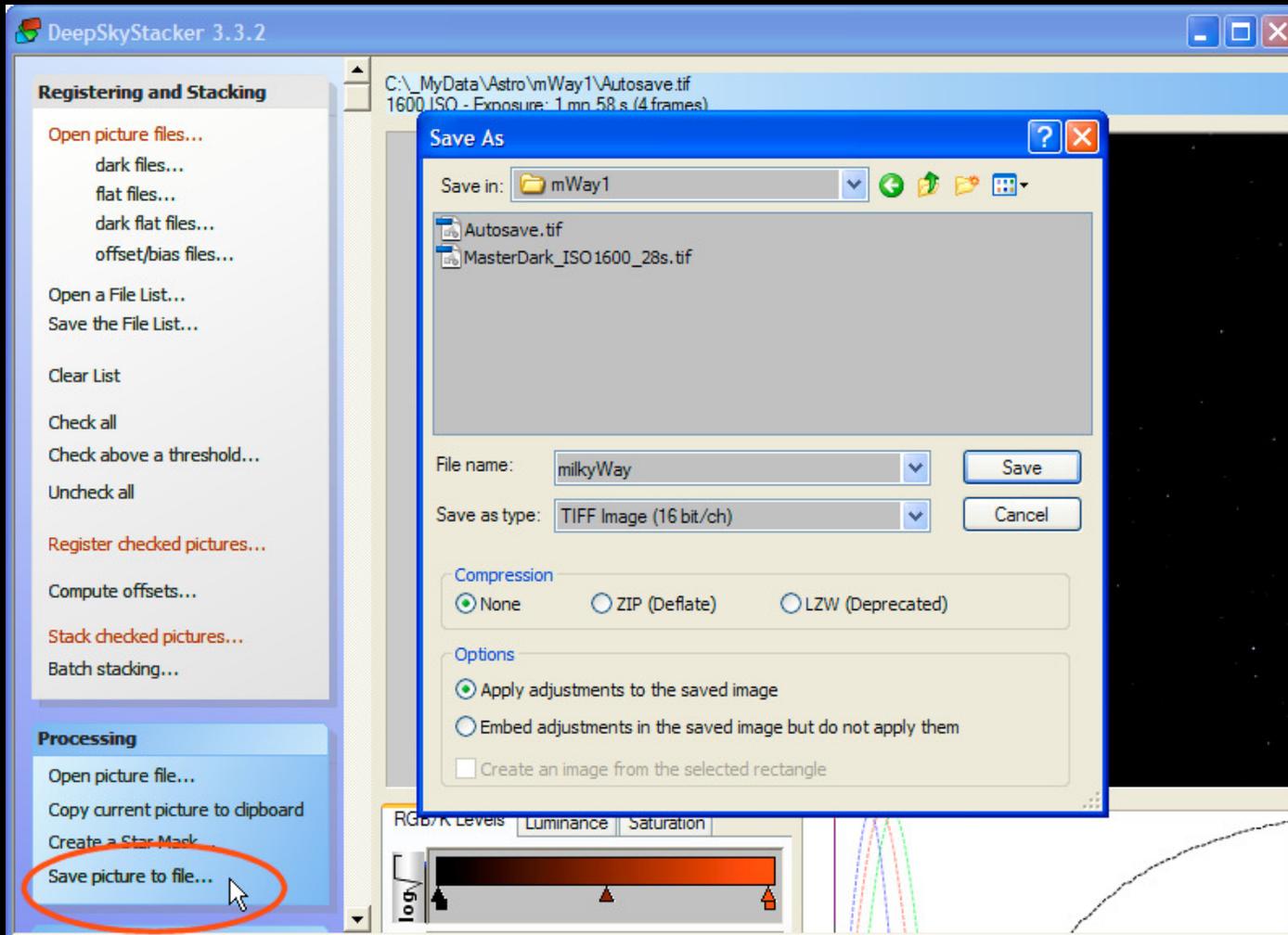
log

Linked settings

Apply [Undo] [Redo] [Refresh] Reset



## Save the picture as a 16-bit TIFF for loading into IRIS.



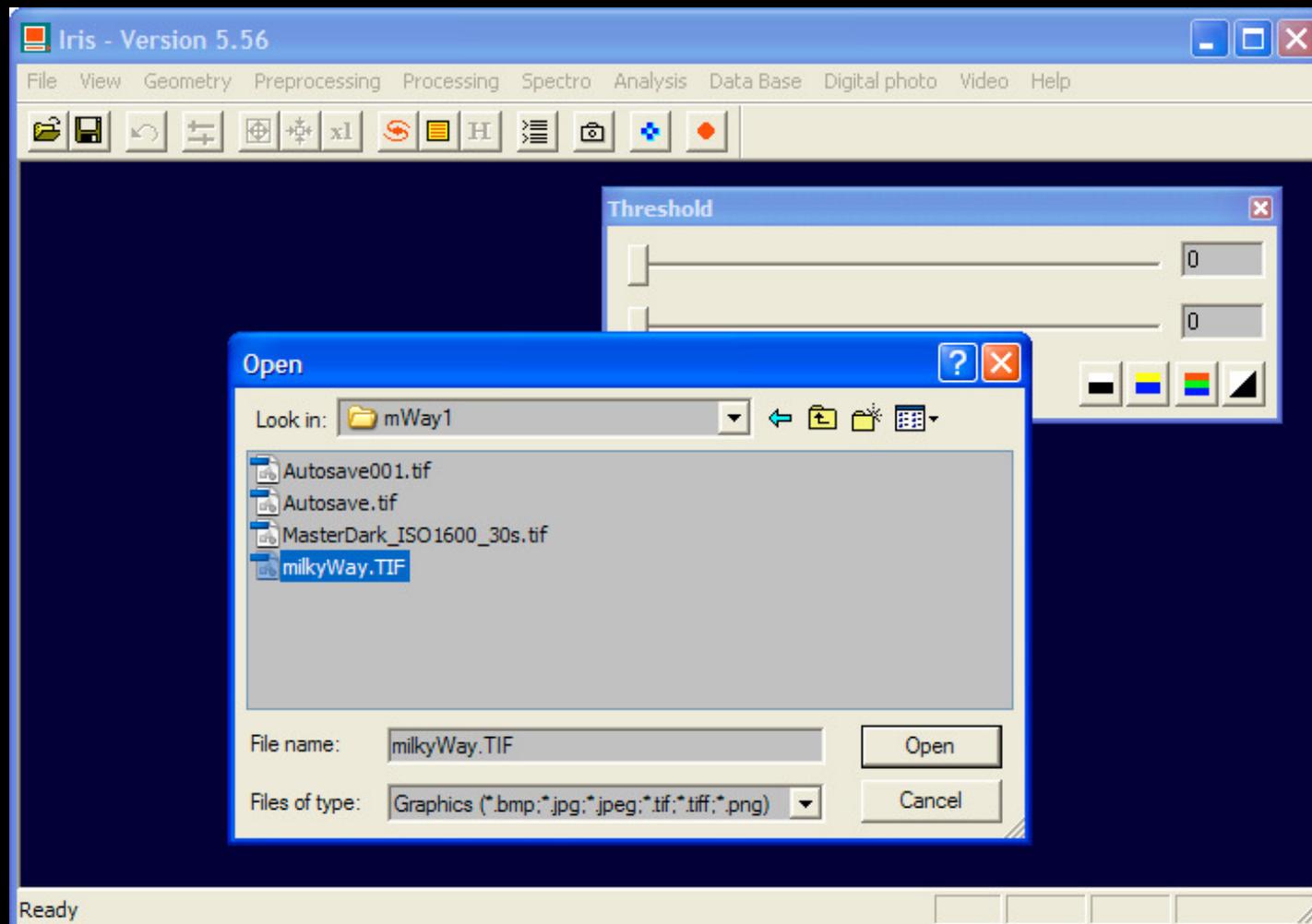


Deep Sky Stacker does good job of stacking, but its image processing features are limited and difficult to use.

In the next step we will use IRIS to do a DDP stretch and save the image as 8-bit, for loading into GIMP.

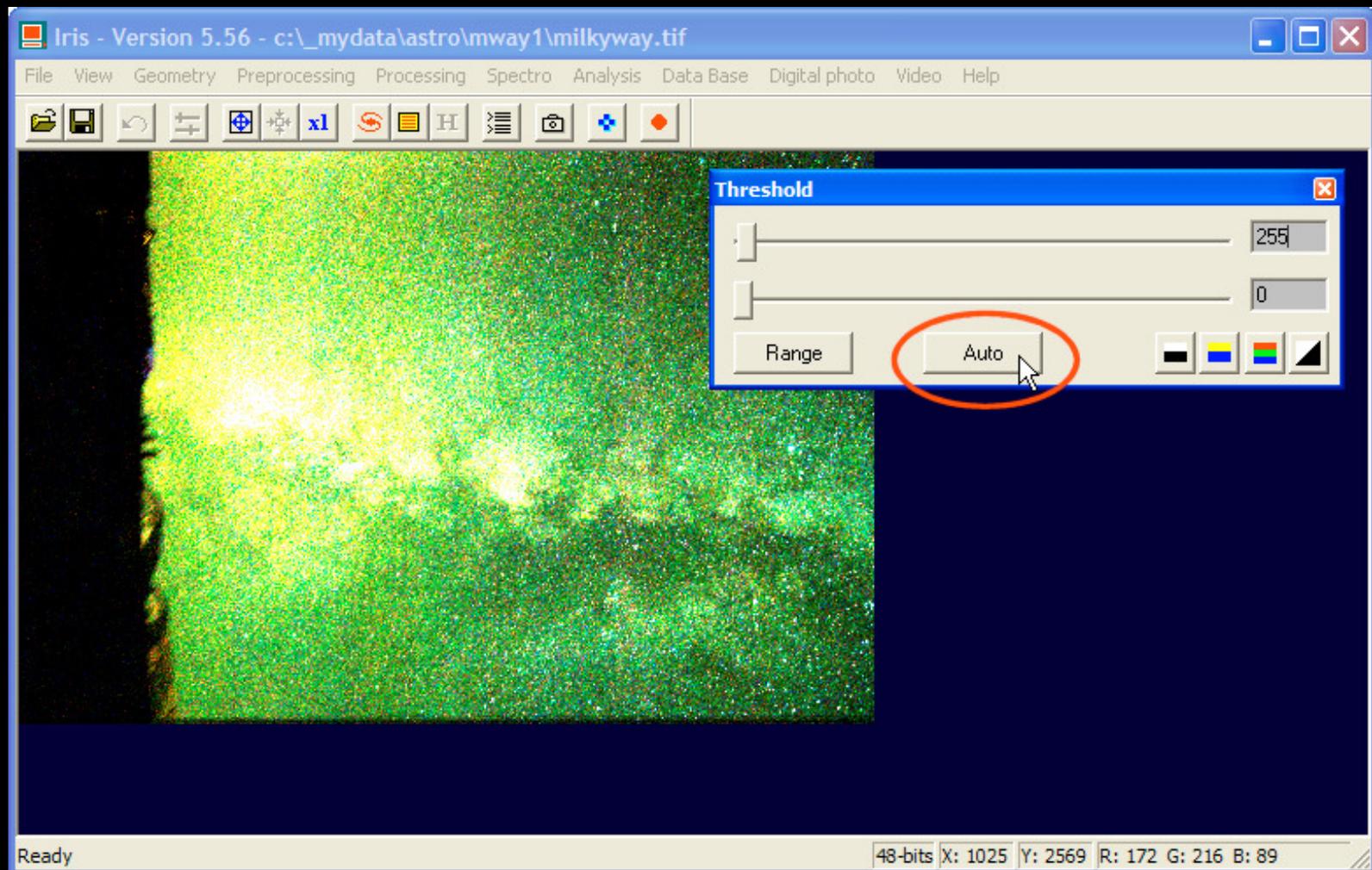


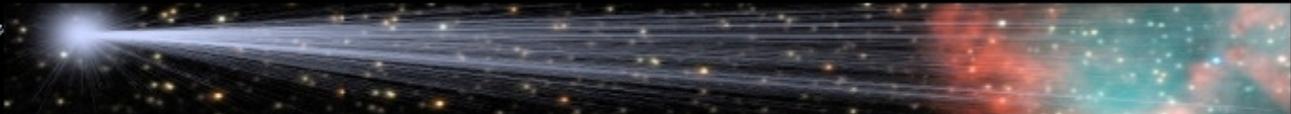
## Open IRIS and load the 16-bit TIFF image



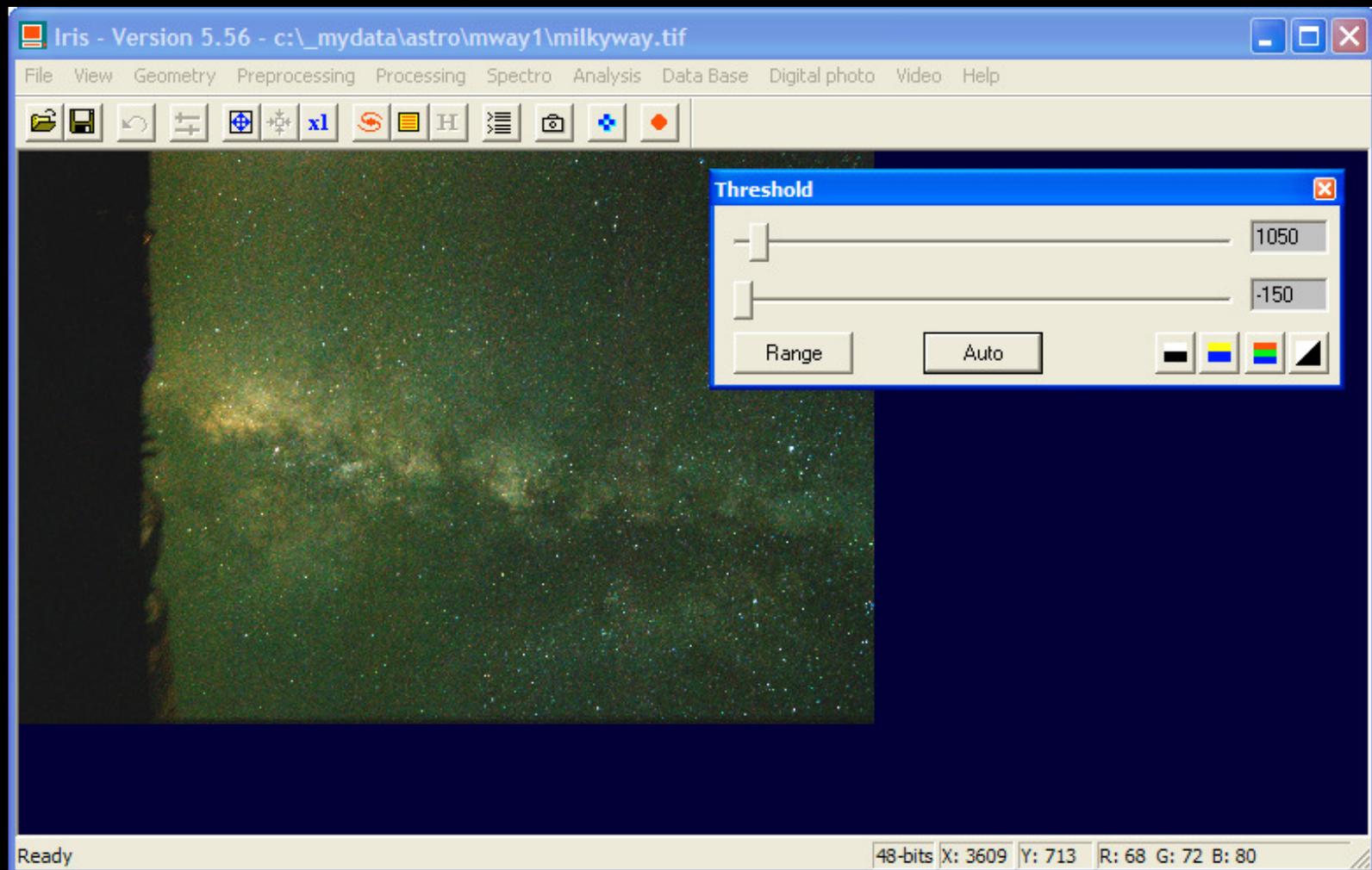


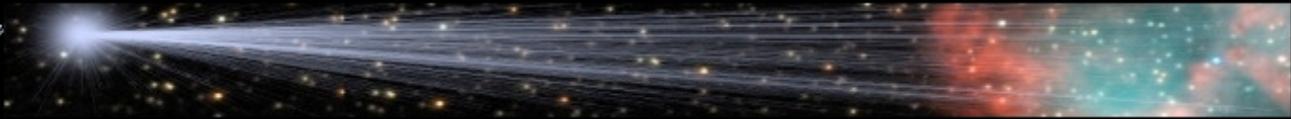
and we get this. Now click *Auto*, in the Threshold window.



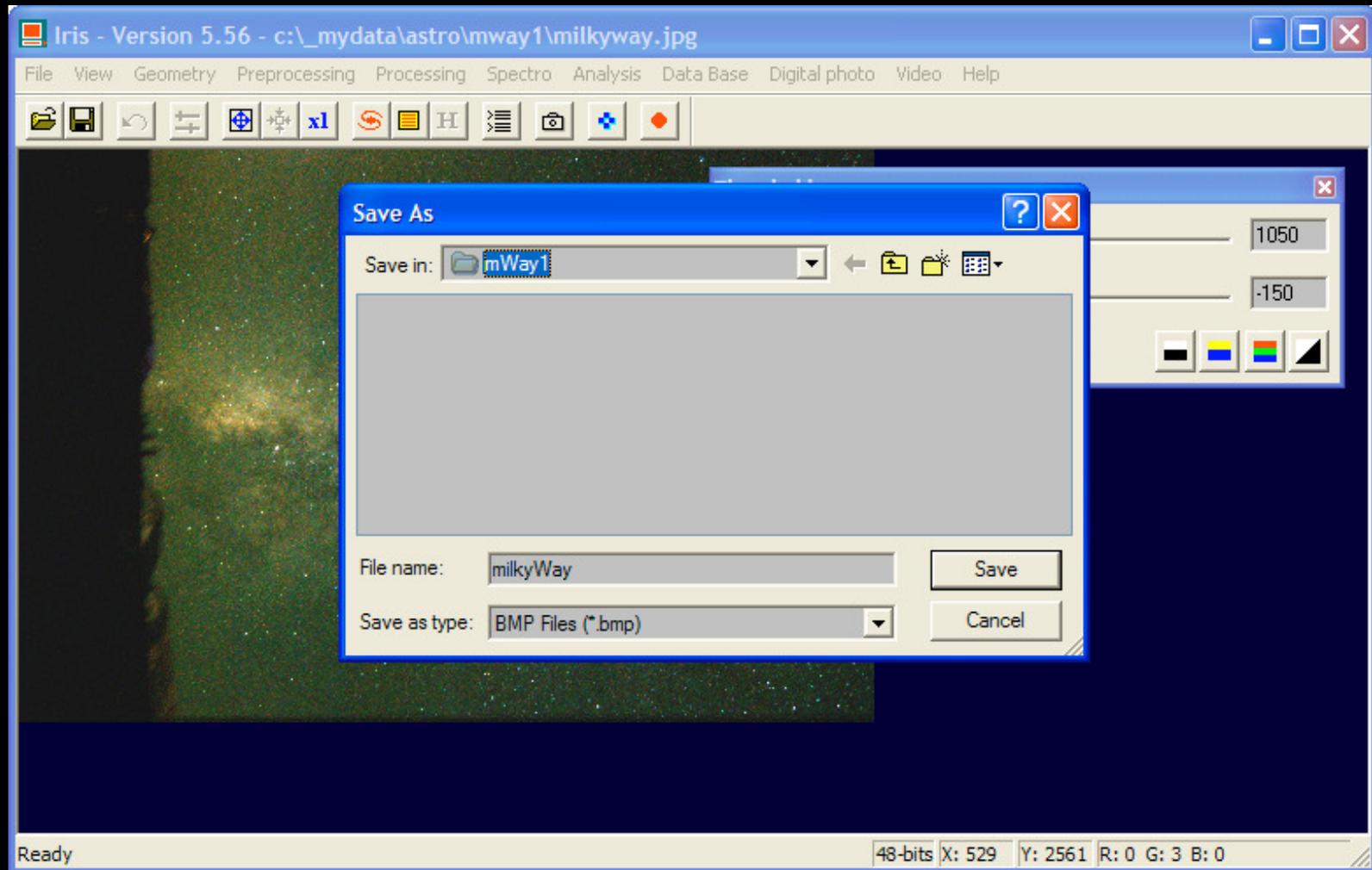


and we get this.

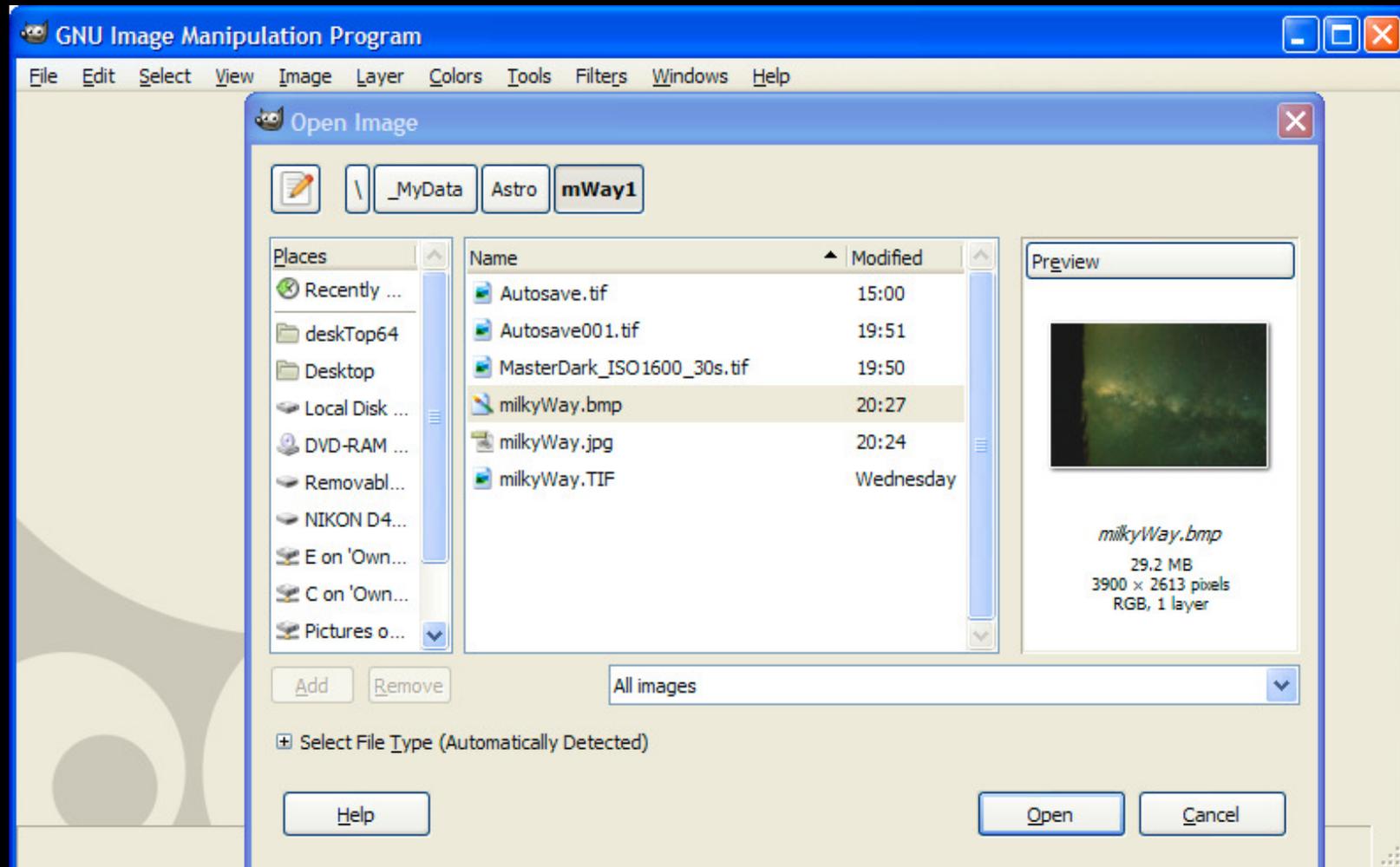


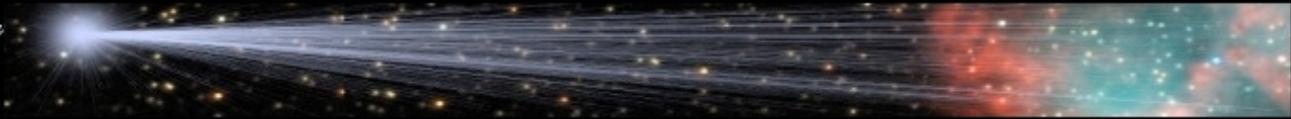


Save the image as a BMP for loading into GIMP.

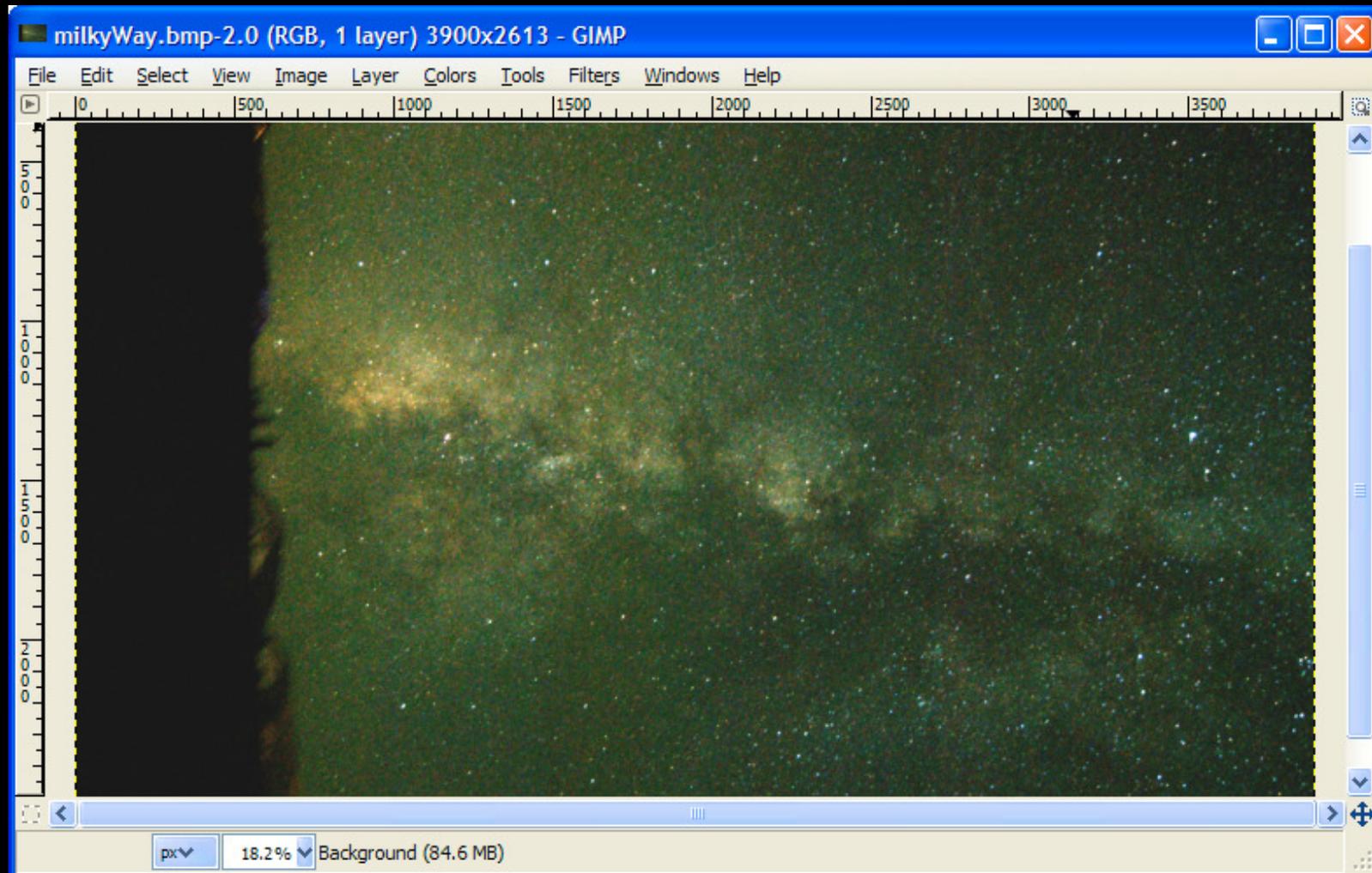


## Open GIMP and load the 8-bit BMP image

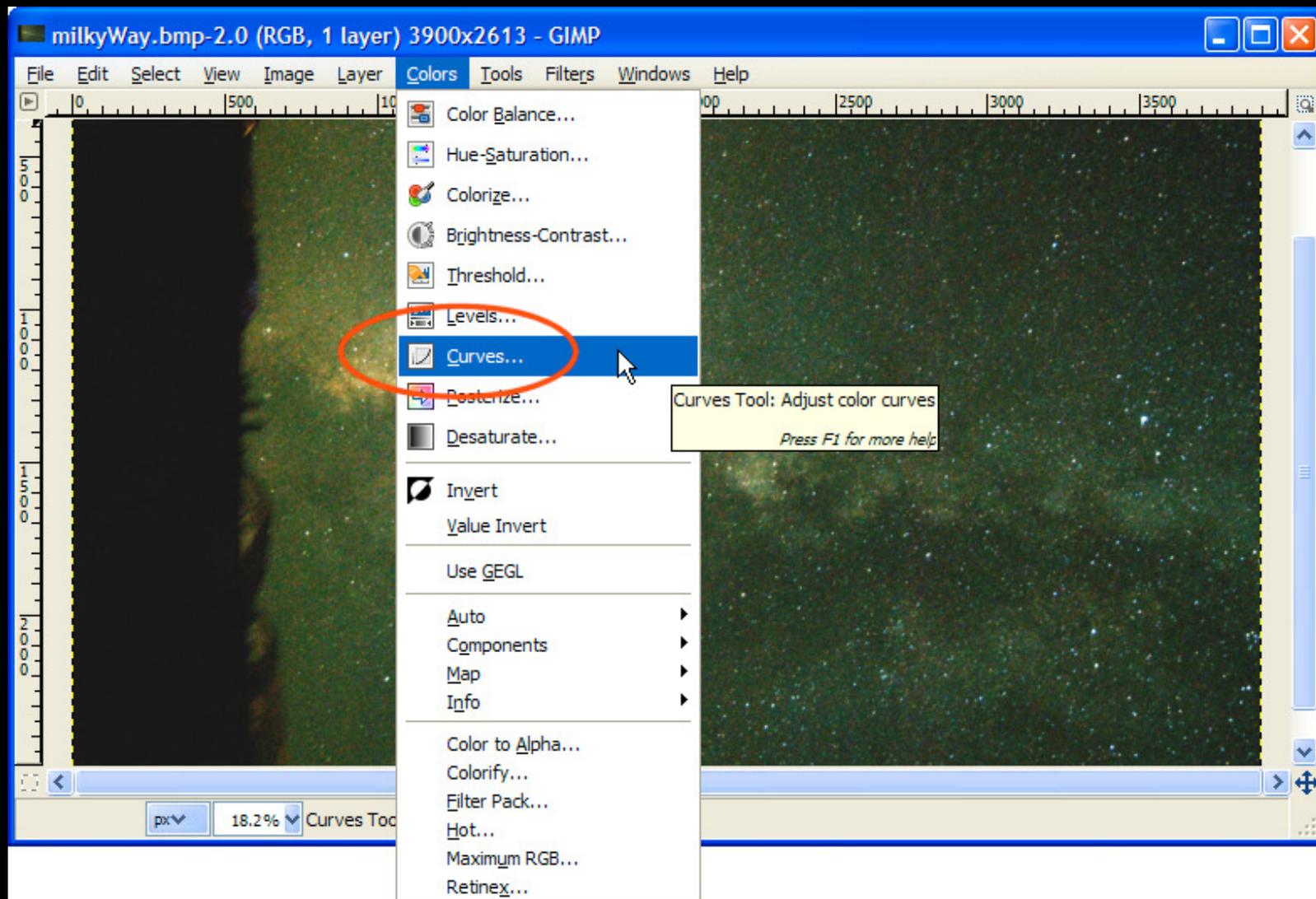




## GIMP's initial screen with our image



Select *Curves*, to make a contrast adjustment.



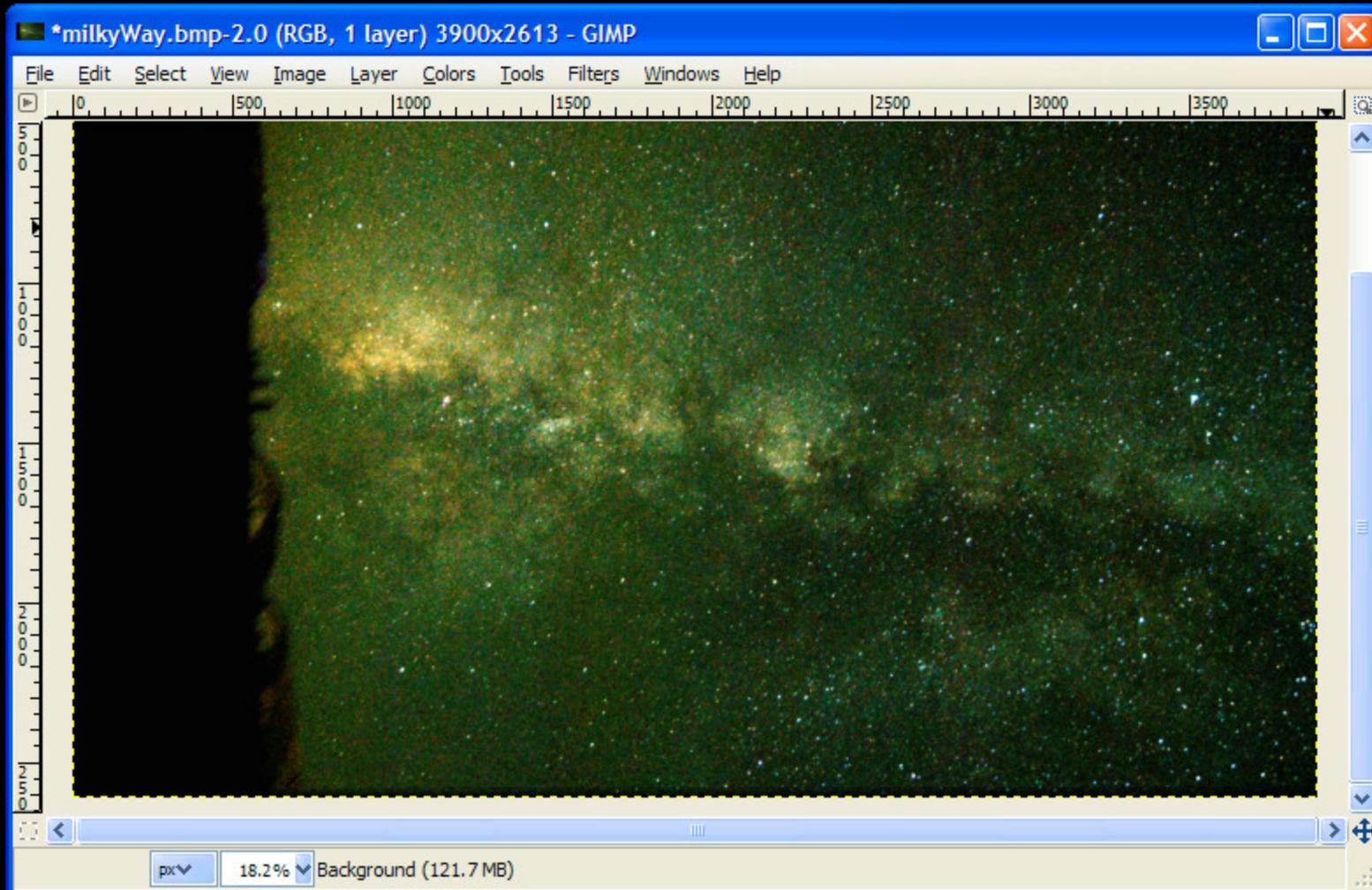


A curve like this increases the contrast.

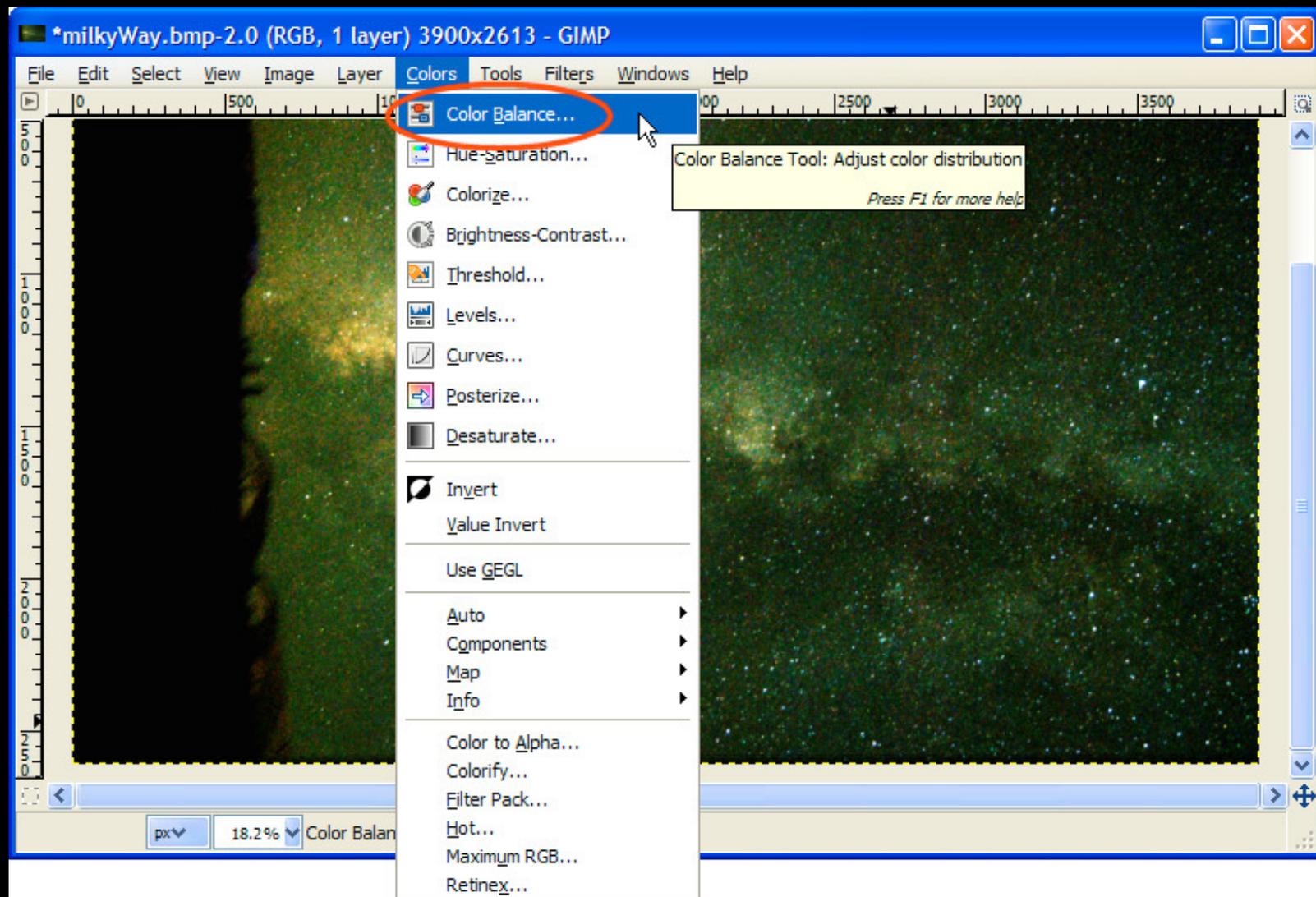
The screenshot shows the GIMP interface with the 'Curves' dialog box open. The main window displays a grayscale image of a galaxy. The 'Curves' dialog box is titled 'Adjust Color Curves' and shows a graph with a curve that increases contrast. The curve starts at the origin (0,0) and ends at (1,1), with a point at x:90. The 'Channel' is set to 'Value' and the 'Curve type' is 'Smooth'. The 'Preview' checkbox is checked. Buttons for 'Help', 'Reset', 'OK', and 'Cancel' are visible at the bottom of the dialog.



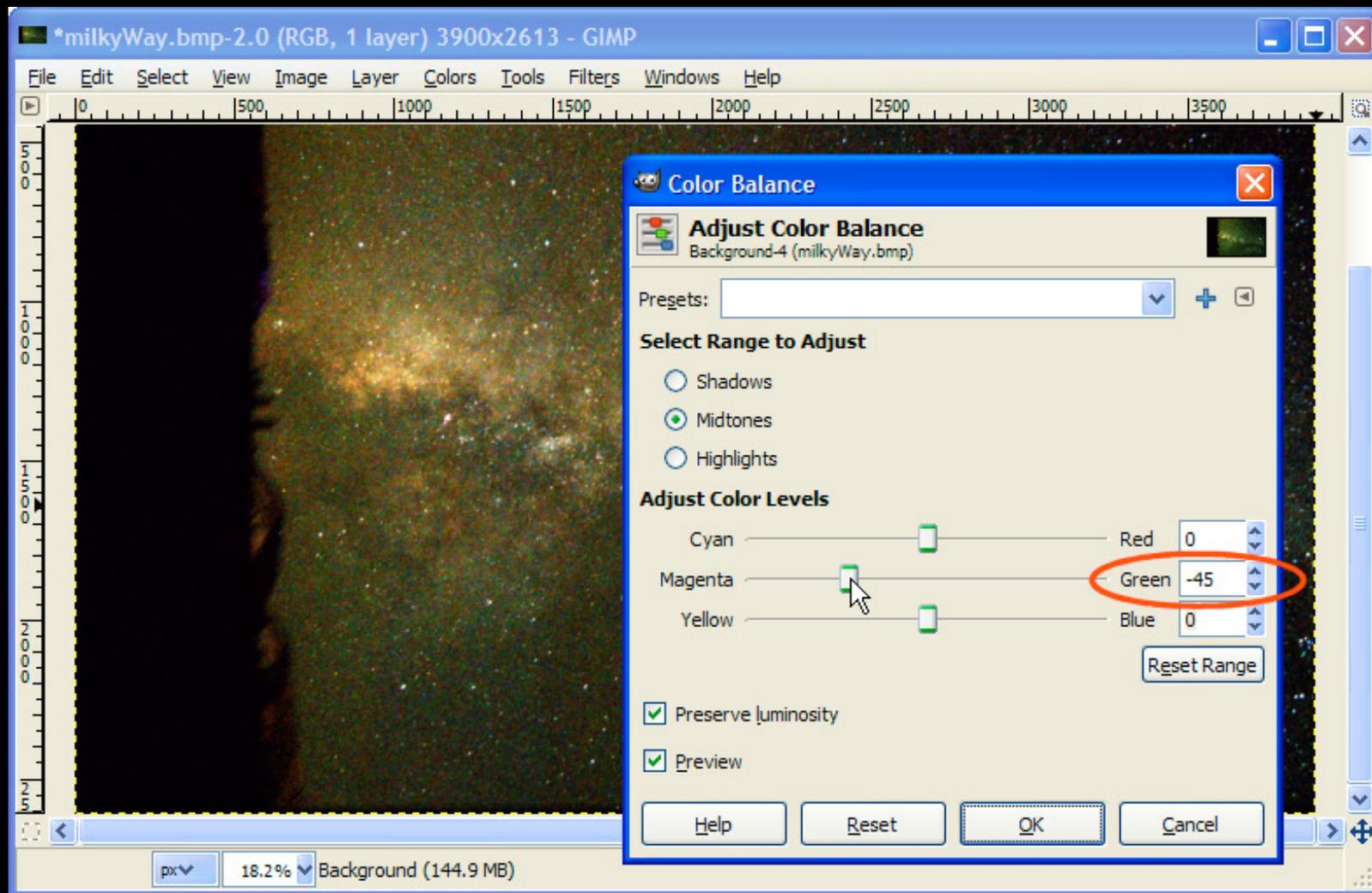
This looks good for contrast, but it's a bit green. Checking the background color shows that the green is about 45% too high.

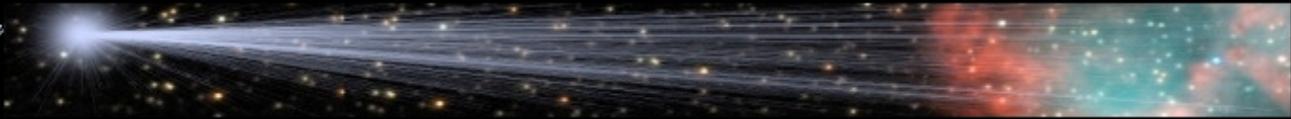


## Select Color Balance....

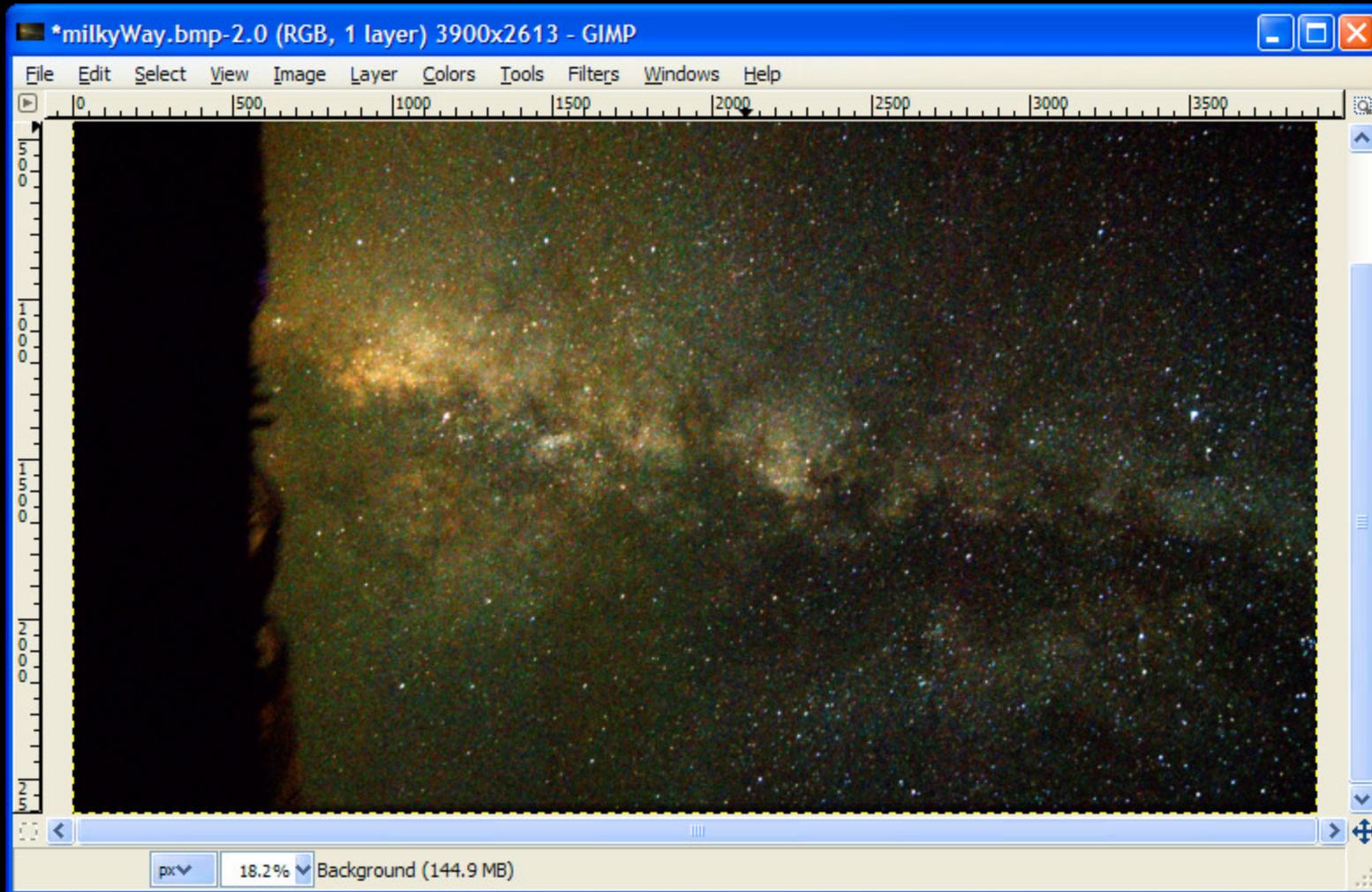


Set the green to -45 and click OK

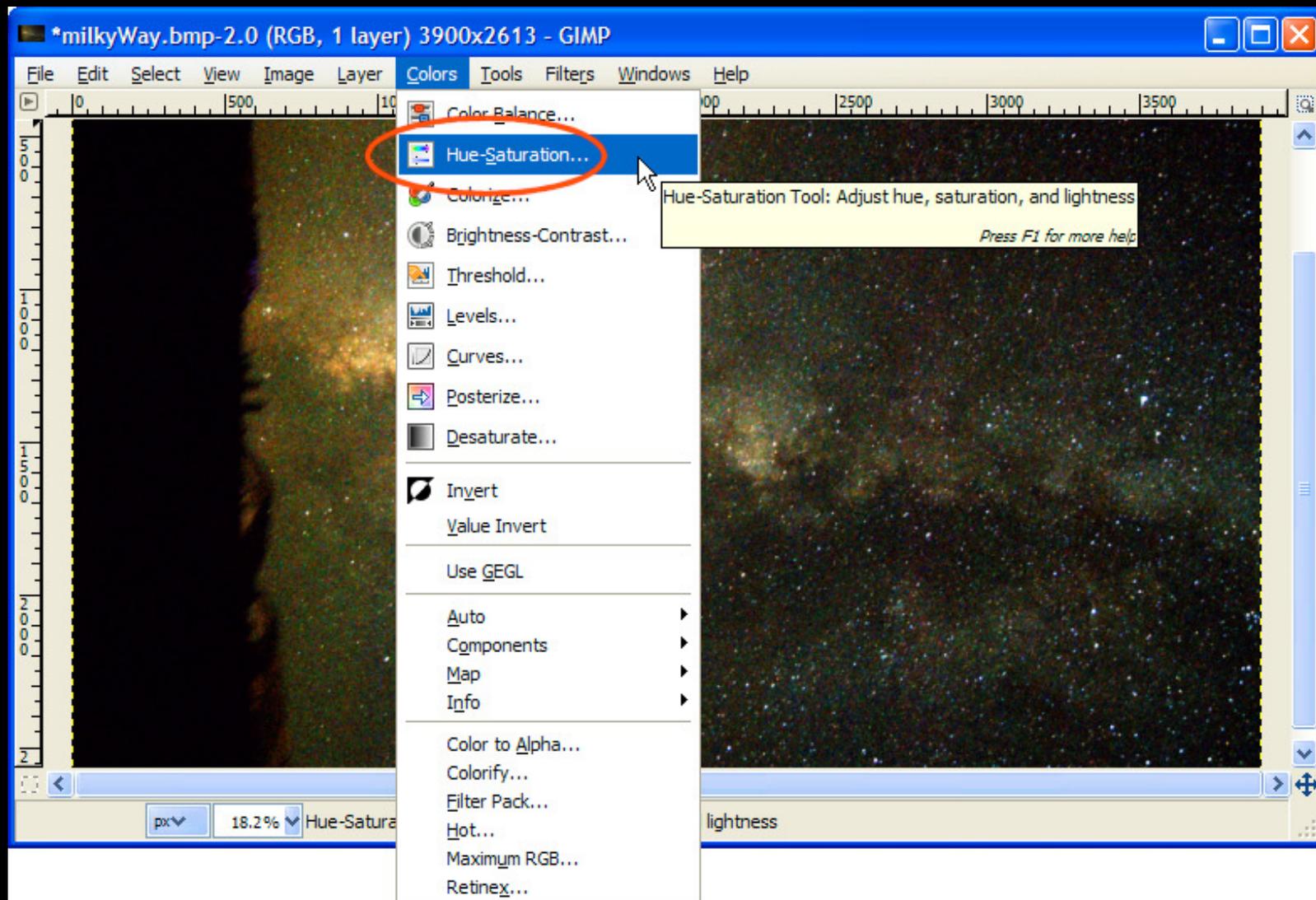




This looks pretty good, but still a bit green.

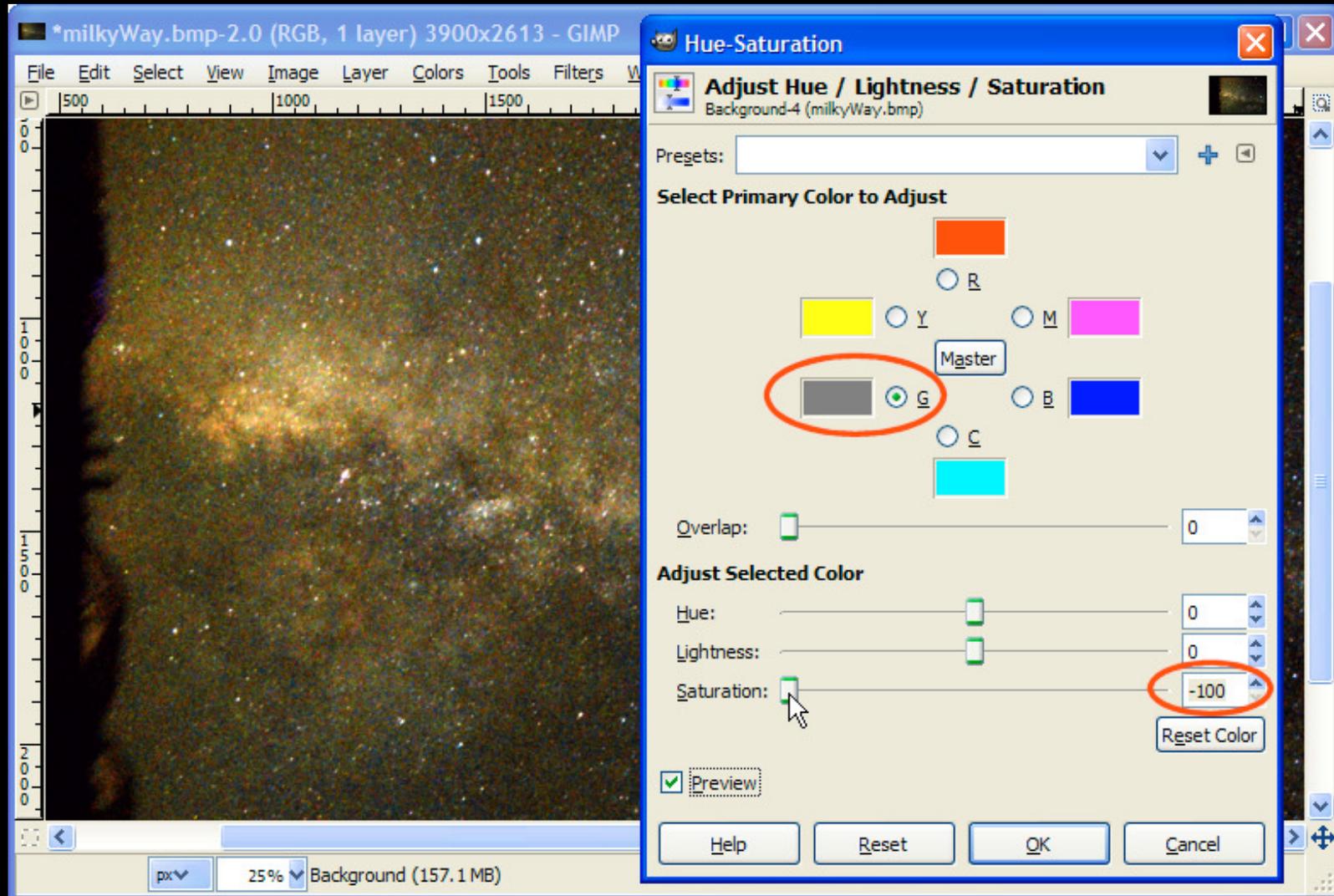


Let's try a *Hue-Saturation* adjustment.

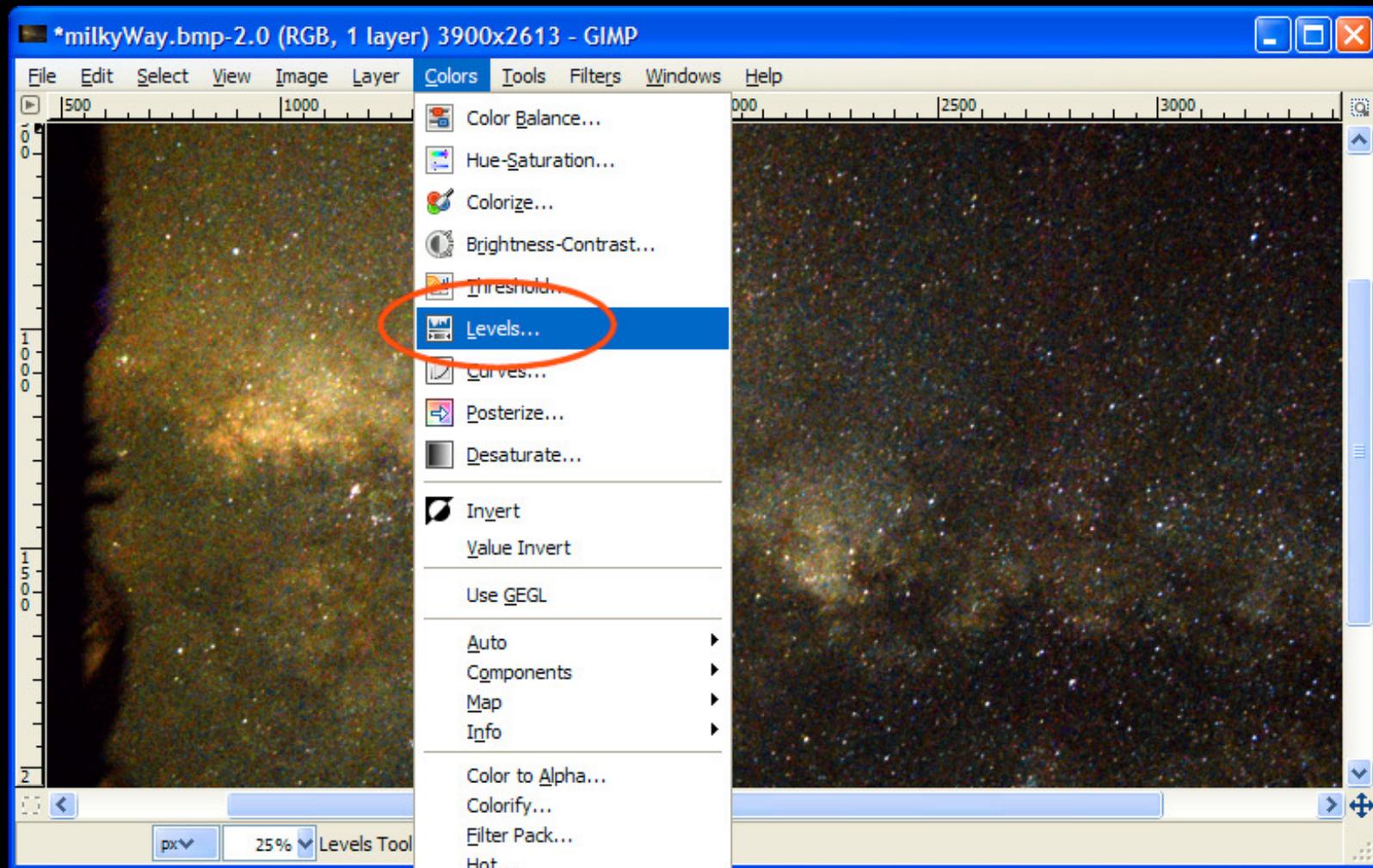




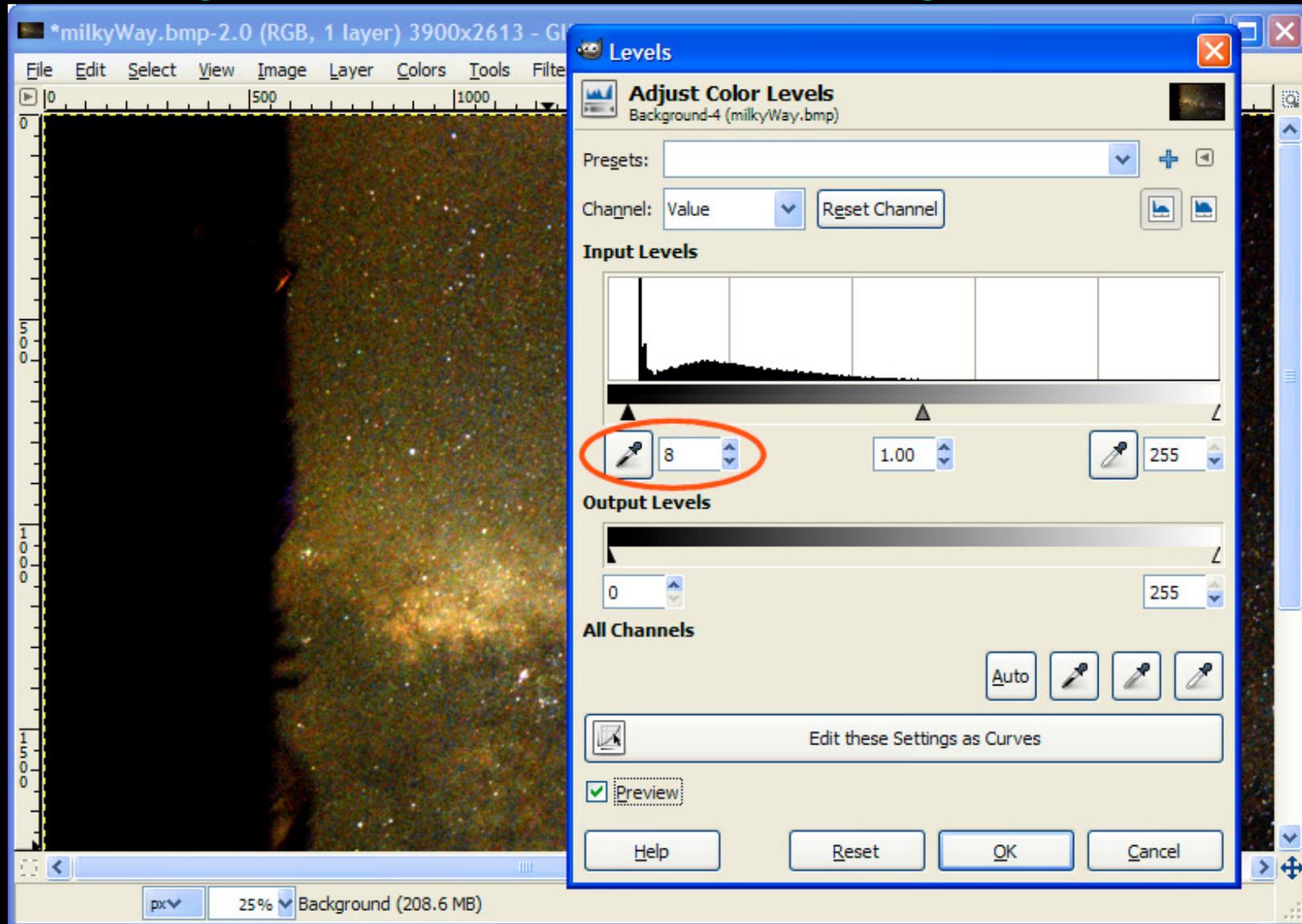
Generally, we don't want any green in an astro image. Select the Green button, set the saturation to -100 and click OK.



Lowering the black point adds more  
"pop" to the image. Select *Levels*.



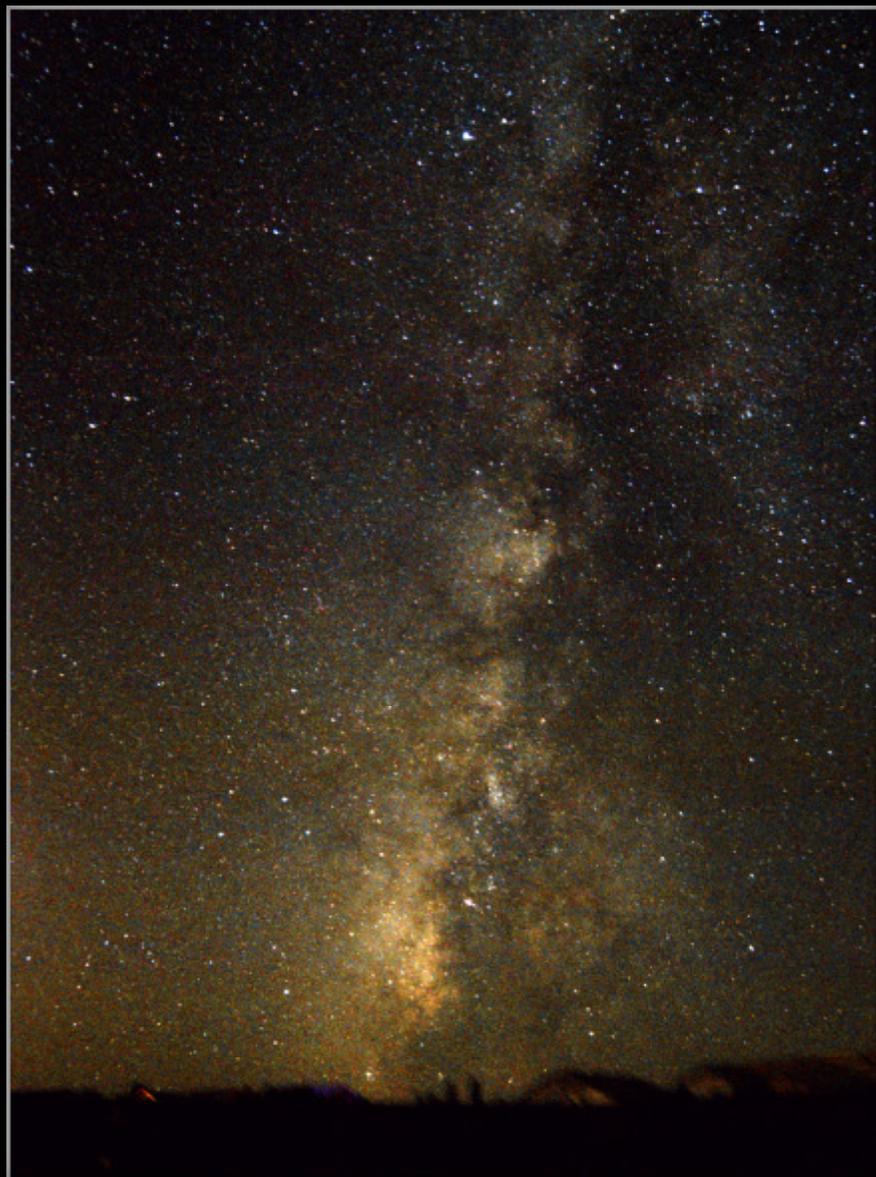
Setting the left slider to about 8 looks good, click *OK*.



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*Bob Franke*



Finished





Best web site for DSLR astrophotography

<http://www.astropix.com/>

Camera Lenses for Astrophotography

[http://www.astropix.com/HTML/I\\_ASTROP/LENSES.HTM](http://www.astropix.com/HTML/I_ASTROP/LENSES.HTM)

Deep Sky Stacker

<http://deepskystacker.free.fr/english/index.html>

IRIS

<http://www.astrosurf.com/buil/us/iris/iris.htm>

GIMP

<http://www.gimp.org/>

This PowerPoint is available at

<http://www.bf-astro.com>

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# DSLR Astrophotography

