Bob Franke

### DSLR Astrophotography



#### Bob Franke

## They say... start with a joke.



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### DLSR Wide-field Astrophotography The Advantages

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



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### ...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.

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### 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.

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### 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



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



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#### Especially at night!



## However, the reward can be great.



© Wally Pacholka - 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



#### 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.



#### 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



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



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### 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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#### Unmodified Canon © Bernhard Hubl



#### Modified Canon © Brian Morganti



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### 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.

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### 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.

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### 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

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

8	DeepSkyStacker 3.3.2							
	Registering and Stacking							-
	dark files							
	flat files dark flat files							
	offset/bias files							
	Open a File List							
	Save the File List							
	Clear List							
	Check all		Light Fra	ames:4	- Dark Frames: 4 - Fla	at Frames:0 -	Dark Flat Frames: 0 -	Offset/Bias Frames:
	Check above a threshold				Path	File 4	Туре	e Scor
	Uncheck all				C:\_MyData\Astro\mWay1\	DSC_00	52.NEF Light	251.8
					C:\_MyData\Astro\mWay1\	DSC_00	53.NEF Light	237.0
	Register checked pictures				C:\_MyData\Astro\mWay1\	DSC_00	54.NEF Light	228.4
	Compute offsets				C:\_MyData\Astro\mWay1\	DSC_00	55.NEF Light	246.0
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	Stack checked pictures				C:\_MyData\Astro\mWay1\	DSC_00	57.NEF Dark	Nį
	Batch stacking				C:\_MyData\Astro\mWay1\	DSC_00	58.NEF Dark	Nį
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#### 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	Actions       Advanced         Register already registered pictures         Automatic detection of hot pixels         Stack after registering         Select the best       100 % pictures and stack them.         Don't forget to add and check flat and offset frames         before stacking	Flat Frames: 0 - Offset/Bias Frames: 0
Uncheck all	Derore stacking.	Type Score
Register checked pictures		F Light 251.83
	Recommended Settings Cancel	F Light 237.09
Compute offsets		F Light 228.47
Stack checked pictures	Stacking parameters OK	Light 246.09
Batch stacking		Dark N/A
Processing	C:\_MyData\Astro\mWay1\ DSC_00	DS9.NEE Dark N/A
Open picture file		

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#### Set the star detection threshold.

ScheepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\New Folder\DSC_0056.NEF	
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	Register Settings         Actions       Advanced         Star detection threshold         37 %         Compute the number of detected stars         37 star(s)	
Uncheck all	Li Reduce the noise by using a Median Filter	t Frames: 0 - Offset/Bias Frames: 0
Register checked pictures Compute offsets Stack checked pictures	Recommended Settings     Cancel       Stacking parameters     OK	Type         Score           Light         NC           Light         NC           Light         NC           Light         NC           Light         NC
Batch stacking Processing		F Dark N/A F Dark N/A F Dark N/A
Open picture file	C:\_MyData\Astro\mWay1\ DSC_0059.NE	F Dark N/A

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#### Click on Stacking parameters.

😴 DeepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\New Folder\DSC_0056.NEF	
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	Register Settings         Actions       Advanced         Star detection threshold       37 %         37 %	
		Tune Crore
Register checked pictures Compute offsets Stack checked pictures Batch stacking	Recommended Settings Cancel Stacking parameters OK	Light NC Light NC Light NC Light NC
	C:\_MyData\Astro\mWay1\ DSC_0056.NEF	Dark N/A
Processing	C:\_MyData\Astro\mWay1\ DSC_0057.NEF	Dark N/A
Open picture file	C:\_MyData\Astro\mWay1\ DSC_0059.NEF	Dark N/A

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#### Select the Standard result mode.

ScheepSkyStacker 3.3.2		
Registering and Stacking	Stacking Parameters	
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 all         Uncheck all         Register checked pictures	Result       Light       Dark       Alignment       Intermediate Files       Cosmetic       Output            • Standard Mode           • Wosaic'' Mode           • Intersection Mode           • Custom Rectangle           • Enable 2x Drizzle         • Enable 3x Drizzle         • Align RGB Channels in final image           • The result of the stacking process is framed by the reference light frame.           • Offset         • e	;/Bias Frames: 0 Score
Compute offsets Stack checked pictures Batch stacking	Temporary Files Folder: C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\ Reduce worker threads priority Cancel Use all available processors OK	NC NC NC N/A N/A
Processing Open picture file	Image: C:\_MyData\Astro\mWay1\     DSC_0058.NEF     Dark       Image: C:\_MyData\Astro\mWay1\     DSC_0059.NEF     Dark	N/A N/A

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#### Select the Average stacking mode for lights.

ScheepSkyStacker 3.3.2					
Registering and Stacking	Stacking Parameters				
Open picture files dark files	Result Light Dark Ali	gnment Intermediate Files Cosm	etic Output		
flat files dark flat files offset/bias files	Stacking mode	C Entropy Weighted (High Dynamic Ra	d Average ange)		
Open a File List Save the File List	Median     Kappa-Sigma clipping	O Maximum			
Clear List	Median Kappa-Sigma cli	Kappa: <b>pping</b>	2.00		
Check all Check above a threshold	Auto Adaptive Weighted	Average Number of iteration	s: 5	Officiat	Piac Frames: 0
Register checked pictures	Per Channel Background C	alibration		e	Score
Compute offsets	Temporary Files Folder: C:\	DOCUME~1\DESKTO~1\LOCALS~1	\Temp\		NC NC
Stack checked pictures Batch stacking	Reduce worker threads pr Use all available processor	iority 's	Cano		NC N/A
Processing Open picture file		C:\_MyData\Astro\mWay1\ C:\_MyData\Astro\mWay1\	DSC_0058.NEF DSC_0059.NEF	Dark Dark	N/A N/A

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#### Select the Median stacking mode for darks.

SeepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\Wew Folder\DSC_0056.NEF	
Open picture files	Stacking Parameters	
dark files	Result Light Dark Alignment Intermediate Files Cosmetic Output	
dark flat files	Stacking mode	
offset/bias files	Average C Entropy Weighted Average (High Dynamic Range)	
Open a File List Save the File List	Median     Maximum	
Clear List	Kappa-Sigma clipping	
Check all	O Median Kappa-Sigma clipping	
Check above a threshold	Auto Adaptive Weighted Average Number of iterations: 5	
Uncheck all	Offset/Bias Fram	nes: 0
Register checked pictures	Dark Optimization Dark Multiplication Factor: 1.0000	Score
Compute offsets		NC
Stack checked pictures	Temporary Files Folder: C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\	NC
Batch stacking	Reduce worker threads priority	NC
	V Use all available processors	N/A
Processing		N/A
Open picture file	C:\_MyData\Astro\mWay1\ DSC_0059.NEF Dark	N/A

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#### Select Automatic alignment.

🕏 DeepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\Wew Folder\DSC_0056.NEF	
Open picture files dark files	Stacking Parameters     X       Result Light     Dark     Alignment     Intermediate Files     Cosmetic     Output	
flat files dark flat files	Transformation used during alignment	
offset/bias files Open a File List Save the File List	Automatic     Automatic     The alignment method is automatically     selected depending on the number of	
Clear List	available stars.	
Check all Check above a threshold	OBicubic	
Uncheck all	◯ No Alignment	Offset/Bias Frames: 0 Score
Compute offsets		NC NC
Stack checked pictures	Temporary Files Folder: C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\	NC NC
Batch stacking	Reduce worker threads priority     Cancel       Use all available processors     OK	N/A N/A
Processing Open picture file		N/A N/A

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#### There is usually no need to keep temp files.

SeepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\New Folder\DSC_0056.NEF	
Open picture files dark files flat files dark flat files offset/bias files Open a File List Save the File List Clear List	Stacking Parameters       Image         Result       Light       Dark       Alignment       Intermediate Files       Cosmetic       Output         Intermediate files creation settings       Intermediate files creation settings       Image       Image	
Check all Check above a threshold Uncheck all	<ul> <li>● TIFF files</li> <li>● FITS files</li> </ul>	Offset/Bias Frames: 0
Register checked pictures Compute offsets		Score NC NC
Stack checked pictures Batch stacking	Temporary Files Folder: C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\          Reduce worker threads priority       Cancel         Use all available processors       OK	NC NC N/A N/A
Processing Open picture file	✓     ✓     C:\_MyData\Astro\mWay1\     DSC_0050.NEF     Dark	N/A N/A

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

SeepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\Wew Folder\DSC_0056.NEF	
Open picture files dark files flat files dark flat files offset/bias files Open a File List Save the File List Clear List	Stacking Parameters       X         Result Light Dark Alignment Intermediate Files Cosmetic Output       Post Calibration Cosmetic settings         Image: Comparison of the set of the s	
Check all Check above a threshold Uncheck all	Filter Size     2 px       Effect Weak     Strong       Detection Threshold     31.2%	Offset/Bias Frames: 0
Register checked pictures	Replace pixel value with the median       Test on first frame         Save an image showing the cleaned pixels for each light frame	Score NC
Stack checked pictures Batch stacking	Temporary Files Folder: C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\ Reduce worker threads priority Cancel OK	NC NC NC
Processing		N/A
Open picture file	C:\_MyData\Astro\mWay1\ DSC_0059.NEF Dar	k N/A

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

😽 DeepSkyStacker 3.3.2		
Registering and Stacking	C:\Temp\stackerUnl\New Folder\DSC_0056.NEF	
Open picture files dark files flat files dark flat files offset/bias files Open a File List Save the File List	Stacking Parameters       Image: Stacking Parameters         Result       Light       Dark       Alignment       Intermediate Files       Cosmetic       Output         Output Files settings       Image: Create Output file       Image: Create Output file       Image: Create HTML description file         Output File Name       Image: Autosave.tif./fits       Image: Create Name       Image: Create Name	
Check all Check above a threshold Uncheck all Register checked pictures	Append a number to avoid file overwrite (001, 002,)   Output Location   Oreate Output file in the folder of the reference frame   Oreate Output file in the folder of the file list   Oreate Output file in	Offset/Bias Frames: 0 Score NC
Compute offsets Stack checked pictures Batch stacking	Temporary Files Folder: C:\DOCUME~1\DESKTO~1\LOCALS~1\Temp\          Reduce worker threads priority       Cancel         Use all available processors       OK	NC NC NC N/A N/A
Open picture file		N/A N/A

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#### Click OK, until you get to this screen.

😽 DeepSkyStacker 3	.3.2	
Registering and Sta	Stacking Steps	
Open picture files dark files flat files dark flat files	Stacking mode: Standard       Alignment method: Automatic         4 detected and used processors	
offset/bias files Open a File List Save the File List Clear List Check all Check above a thresh	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 Hat Divide data strike and exposure Vec	
Uncheck all Register checked pictu	-> No Flat Estimated Total exposure time: 1 mn 57 s	Score NC
Stack checked picture	(the total exposure time is computed considering that all the checked light frames are kept for the stacking process)	NC NC
Processing	Recommended Settings     Cancel       Stacking parameters     OK	N/A N/A
Open picture file	- C:\_MyData\Astro\mWay1\ DSC_0059.NEF Da	ark N/A

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

😴 DeepSkyStacker 🛛	3.3.2					
Registering and Sta	cking	C:\Temp\stackerl	Inl\New Folder\DSC_0056.NEF			
Open picture files dark files flat files dark flat files offset/bias files						
Open a File List Save the File List Clear List	Stacking	Stacki Saving Final i				
Check all Check above a thresh						
Uncheck all	Estimated rom	naining time: 14 a		Stop	- Offs	et/Bias Frames: 0
Register checked pict	re	laining time. 145		<u></u>	/pe	Score
			C:\_MyData\Astro\mWay1\	DSC_0052.NEF	Light	251.83
Compute offsets			C:\_MyData\Astro\mWay1\	DSC_0053.NEF	Light	237.09
Stack checked picture	s		C:\_MyData\Astro\mWay1\	DSC_0054.NEF	Light	228.47
Batch stacking			C:\_MyData\Astro\mWay1\	DSC_0055.NEF	Light	246.09
			C:\_MyData\Astro\mWay1\	DSC_0056.NEF	Dark	N/A
Processing			C:\_MyData\Astro\mWay1\	DSC_0057.NEF	Dark	N/A
Open picture file			C: \_MyData \Astro \mWay1\	DSC_0058.NEF	Dark	N/A
Open picture file	-		C:\_MyData\Astro\mWay1\	DSC_0059.NEF	Dark	N/A

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#### The Final Stacked Image

.....



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

😽 DeepSkyStacker 3.3.2		
Registering and Stacking	C:\_MyData\Astro\mWay1\Autosave.tif 1600JSO - Exposure: 1 mp 58 s (4 frames)	
Open picture files dark files flat files dark flat files offset/bias files Open a File List Save the File List Clear List	Save As Save in: mWay1 Autosave.tif MasterDark_ISO 1600_28s.tif	
Check all Check above a threshold Uncheck all Register checked pictures Compute offsets Stack checked pictures Batch stacking	File name: milkyWay   Save   Save as type:   TIFF Image (16 bit/ch)   Cancel   Compression   None   ZIP (Deflate)   LZW (Deprecated)   Options <ul> <li>Apply adjustments to the saved image</li> </ul>	
Processing Open picture file Copy current picture to dipboard Create a Star Mack Save picture to file	Embed adjustments in the saved image but do not apply them     Create an image from the selected rectangle	

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

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

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

Iris - Version 5.56	
File View Geometry Preprocessing Processing Spectro Analysis Data Base Digital photo Video Help	
Open         Look in:       mWay1         Autosave001.tif         Autosave.tif         MasterDark_ISO1600_30s.tif         mikyWay.TIF         File name:       mikyWay.TIF         Files of type:       Graphics (*.bmp;*.jpg;*.jpeg;*.tif;*.tiff;*.png)	
Ready International Internationa	11.

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

Focal Dointe Observatory -

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File View Geometry Preprocessing Processing Spectro Analysis Data Base Digital photo Video Help 같이 다 한 환 화 오 미 표 결 회 한 호	
Threshold	
Ready 48-bits X: 1025 Y: 2569 R: 172 G: 216 B: 89	11.

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#### and we get this.

Iris - Version 5.56 - c:\_mydata\astro\mway1\milkyway.tif	
File View Geometry Preprocessing Processing Spectro Analysis Data Base Digital ph	oto Video Help
Image     Image	Le construction de la constructi
Ready	48-bits X: 3609 Y: 713 R: 68 G: 72 B: 80

#### Save the image as a BMP for loading into GIMP.

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Iris - Version 5.56 - c:\_myd	lata\astro\mway1\milkyway.jpg	
File View Geometry Preprocessing	Processing Spectro Analysis Data Base Digital photo Video Help	
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	Save in:     Image:	
Ready	48-bits X: 529 Y: 2561 R: 0 G: 3 B:	0 //

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Focal Dointe Observatory

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

😅 GNU Imag	ge Manip	ulation Program				
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		🛞 Recently	Autosave.tif	15:00		
		🖻 deskTop64	Autosave001.tif	19:51		
		🖻 Desktop	MasterDark_ISO 1600_30s.tif	19:50		
		🛥 Local Disk 😑	🖄 milkyWay.bmp	20:27		
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		Help			Open Cancel	
				_		

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#### GIMP's initial screen with our image



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#### Select Curves, to make a contrast adjustment.

📟 milkyWay.bmp-2.0 (RGB, 1 layer)	3900x2613 - GIMP	
<u>File E</u> dit <u>S</u> elect <u>V</u> iew <u>I</u> mage <u>L</u> ayer	<u>Colors Tools Filters Windows H</u> elp	
▶ 0, 1, 1, 1, 1, 500, 1, 1, 1, 10	Color Balance	ه ليبيني
	Hue-Saturation	2 · · · ·
<u>0</u>	Colorize	
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-	Dignutess-Condiast	
	Threshold	
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8_	Curves	
-	Bosterize Curves Tool: Adjust color curves	
	Desaturate     Press F1 for more help	
<u>1</u> -	Invert	
	Value Tavert	
-	Use <u>G</u> EGL	
2	Auto	
	Components	
°-	Map	
	Colorify	
	Eilter Pack	<u>&gt;</u> +
px 18.2% Curves Too	<u>H</u> ot	
	Maximum RGB	
	Retine <u>x</u>	

#### A curve like this increases the contrast.



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



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#### Select Color Balance....

*	milky\	Vay.bn	ър- <mark>2.</mark> 0	(RGB,	1 laye	r) 390	0x2613	- GIMP	)							_   □	$\times$
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						F	Retine <u>x</u>										

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#### Set the green to -45 and click OK

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8-									Select R	ange to	Adjust							
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This looks pretty good, but still a bit green.



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

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

Focal Dointe Observatory :

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

\*milkyWay.bmp-2.0 (RGB, 1 layer) 3900x2613 - GIMP



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

🛤 *milkyW	ay.bmp-	2.0 (RGB,	1 layer	) 3900	)x2613	- GI	🧧 Levels	
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### Finished



Best web site for DSLR astrophotography http://www.astropix.com/

Camera Lenses for Astrophotography 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

