Canon EOS 300d astrophotography

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*****Main equipment

- Vixen 4" achromatic refractor
 - Focal length: 1000mm
 - Focal ratio: f/9.8
- Vixen GP equatorial mount
- Vixen Skysensor 2000 PC
- Laptop PC

*****Main software

– DSLR Focus, MaxDSLR, Photoshop

*Camera

- Canon EOS 300D digital SLR (body)
 - CMOS sensor size: 22.7x15.1 mm
 - Pixel size: 7.4x7.4 microns
 - 6.3 megapixel resolution (3072x2048)
 - 12 bit per color channel R,G,B (RAW format)
 - Weight body plus battery and CF card: 649 gr
- Canon EF 24-85mm f/3.5-4.5 USM lens
 - Weight: 380 gr

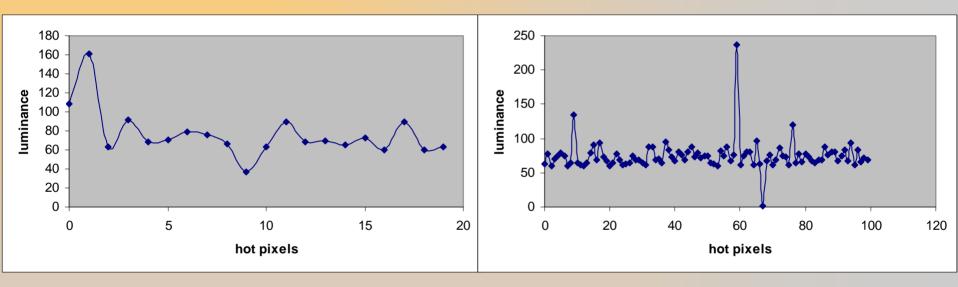
*** Pros for the 300D**

- Big CMOS sensor 23x15mm, with low noise
- High resolution: 3072x2048 active pixels
- Shutter speeds: 1/4000-30sec plus BULB mode
- ISO speeds: 100-200-400-800-1600
- Lightweight
- Widely useable with all Canon compatible lenses
- Can be used for regular photography

*****Cons for the 300D

- Low response to H-alpha due to IR-cut filter of CMOS sensor
- 12 bit per color channel R,G,B (RAW format) instead of 16 bit for most astronomical CCDs
- No mirror lock up
- No cooling possible: better operation during cold ambient
- No multiple exposure mode
- Optical viewfinder provides low magnification
- LCD monitor no live preview

***Hot pixels comparison**



1 frame: 30 sec – ISO 800

1 frame: 15 min – ISO 800

<u>Program used</u>: Dead/hot Pixel Test (c) Michael Salzlechner Threshold for hot pixels=60, Threshold for dead pixels=250 17/02/2006 Kostas Christodoulopoulos

*** Russian Firmware Hack**

- Custom Functions
 - Mirror lock up
- ISO speed 3200

Canon EOS 300D → Canon EOS 10D

*****Canon EOS 300D modification

- Removal of CMOS sensor IR-cut filter
 - Increased H-alpha sensitivity
 - Uncalibration (White balance, Auto focus, Manual focus)
- Plans for Peltier cooling

***Useful accessories**

- AC adapter kit ACK-E2
- RS-60 E3 remote control
- Battery pack BG-E1
- Angle finder C

***Astrophotography tips**

- Balanced, cooled system
- Steady mount (no vibrations)
- Skysensor adjustments (PEC, backlash)
- Polar alignment (star drift method)
- Good seeing
- Preferably dark sky
- Object in high altitude for better results
- Less optical elements more image quality
- Filters to reduce chromatic aberration (achromatic refractors)

***Astrophotography methods**

- Tripod
- Piggy-back
- Prime focus
- Eyepiece projection

*****Typical camera settings

- Auto Rotate: off
- Image quality RAW, ISO range 400-800
- Mode: Manual
- Manual Focus to infinity (piggy-back)
- Mirror lockup enabled (planets) & self timer enabled

*****Calculations

- Image scale
- Field of view
- Chip size
- Ideal Image scale:
- 2"/pixel (DSO)
- 0.5"/pixel (planets)

Ron Wodaski's CCD Calculator - Canor File Settings View Help	n EOS 300D	FOV	
New Astronomy Press	CCD Calculator		
Telescope Vixen 102M	Chip size 15.2mm x 22.7mm		
Aperture 102 Add	Image scale 1.53 arcsec/pix Save		
Barlow or 1	Field of view 52.1 x 78.1 arcmin Exp. Target CFZ (microns)		
Focal length 1000 📫 Recalc	N/A 211.29		
Camera Canon EOS 300D	1M51.jpg	Image shrunk to 69% to	show FOV.
Pixel size 7.4 ÷ × 7.4 ÷ ✓	15.2mm x 22.7mm		min
Bin mode 1x1 ▼ Add Exit Remove	Chip compared to 35mm film		
Last ten telescopes and cameras	v. 1.4.	1	
Vixen 102M	< > Clear		
Canon EOS 300D	< > Clear		

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***Tripod astrophotography**

- Star trails
- Solar scenes (sunset, sunrise, eclipses)
- Lunar scenes (moonset, moonrise, eclipses)
- Wide field (Milky Way, Constellations)



*** Piggy-back astrophotography**

- Bright deep sky objects
- Wide field (Milky Way, Constellations)



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* Recommended Canon lenses for piggy-back astrophotography

- Wide angle
 - EF 15mm f/2.8 Fisheye
- Normal
 - EF 50mm f/1.4 USM
- Tele photo
 - EF 100mm f/2 USM
 - EF 200mm f/2.8 L II USM
 - EF 300mm f/4.0 L USM

(remember **digital factor**=1.6)

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*** Prime focus astrophotography**

- Deep sky objects
- Multiple stars
- Sun (disc, sunspots, eclipses)
- Moon (disc, eclipses) & planets





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*** Eyepiece projection astrophotography** (w/wo Barlow lens)

- Planets
- Sun
- Moon





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*** Piggy-back astrophotography example**

Orion sword Location: Tripotama Achaias Date: 06/11/2005



– Equipment preparation

- Scope in horizontal position, cooled & balanced
- Skysensor setup (location, time, mount mode)
- Polar alignment (star drift method)
- 3-star alignment with Skysensor
- Perform GOTO star Alnitak
- Center star Alnitak in the scope field of view (illuminated reticle eyepiece)

– Camera preparation

- Camera battery fully charged
- Camera mounted piggy-back
- Manual Focus set to infinity
- Camera connected to the laptop (USB port)
- DSLR Focus started camera connected
- Bulb mode selected
- Image RAW format selected
- Serial cable for long exposures enabled (USB port)
- Test shots to adjust focus and camera exposure settings (ISO, Tv, Av)

– Image capture

- 3 frames x10 min ISO 800
- 1 dark frame x10 min ISO 800
- Problems encountered
 - Dew in camera lens and scope lens
 - Some light pollution

– Image processing

MaxDSLR

• Set Calibration (Dark frame)

et Calibration					?
🗂 Calibrate Bias	🔽 Calibrate Dark	🗧 🖂 Calibrate Fla	at 🗂 Dark Su	ıbtract Flats 🔲 Bia	s Subtract Flats
Name	Type Filter	Duration	Image Size	Binning Setpoin	t Count
🗹 Dark 1	DARK	0.00s	1×1	1×1 N/A	1
DARK Group Properties File Name CRW_2381-DAR CRW_2381-DAR	K.CRW	Permove		ear All Groups Dark Frame S Auto-Scale Scale Factor Combine Typ Average Add I Apply To	▼ 1.0000 De ▼ Remove
Auto-Generation	-				
Source Folder				V Include Subf	olders
Auto-Generate	Repla	ace w/ Masters		ОК	Cancel

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MaxDSLR

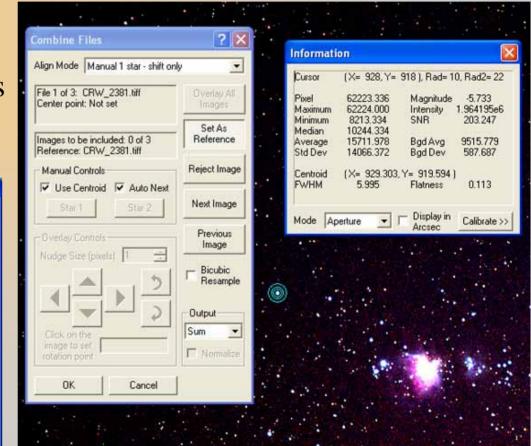
Camera Raw
 Images calibrated
 and converted to
 TIFF 16-bit format

Selected Images and Files	Convert To File Format	Size Format
CRW_2379.CRW	TIFF	16-bit Int 🔄
CRW_2380.CRW	Auto Stretch Add suffix	Compression Type
	Max Val 👻	Uncompressed 💌
	Path Write Out	put to Source Folder
	If destination already exists	Perform Calibratio
Select Files Select Images	Skip save	ОК
Show path Remove	move to subfolder back	

MaxDSLR

• Combine TIFF images (align mode selected)

Look in: C CRW_23	12 Store 185	- 🖬 🎦 🕈 💽-
CRW_23	91.tiff	
File <u>n</u> ame:	"CRW_2381.tiff"	"'CRW_2379.tiff" "CRW_2380
	"CRW_2381.tiff" TIFF Images (*.tif	
File <u>n</u> ame: File Fil <u>t</u> er: File Format		
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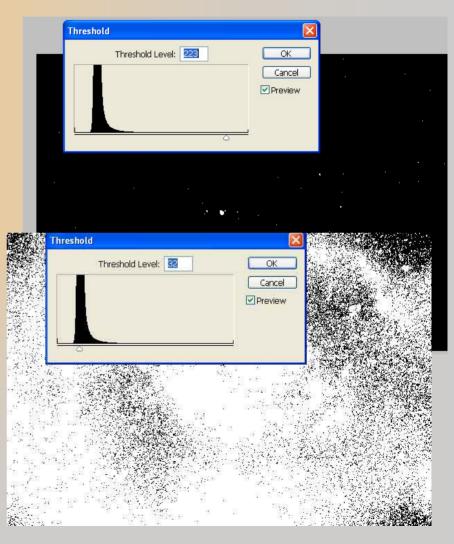


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Photoshop

• Find white/black points (threshold adjustment) in the result image

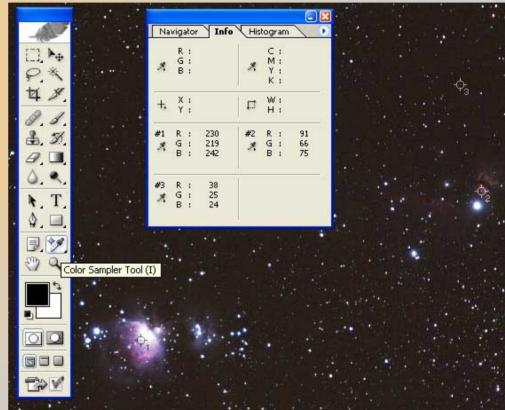




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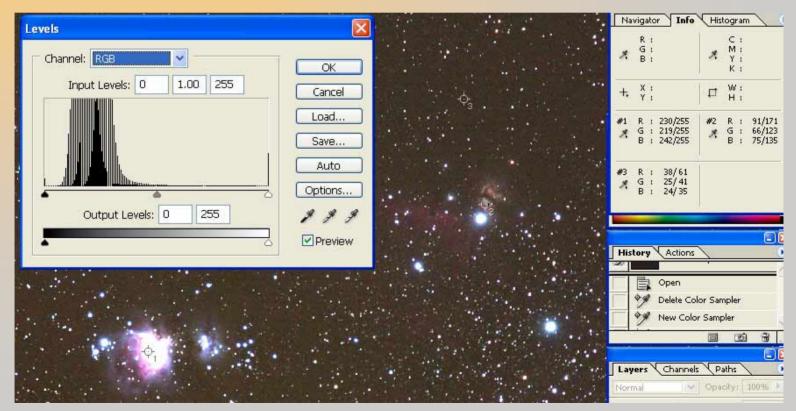
Photoshop

• Select black/white points (Color sample tool)



Photoshop

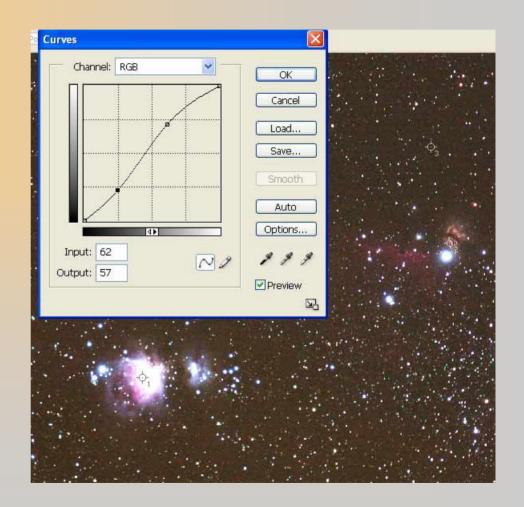
- Correct image black/white points with Levels (R,G,B channels)
- Adjust brightness with midtones



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Photoshop

 Enhance image brightness & contrast with Curves (R,G,B channels)



Photoshop

• Enhance image details with Unsharp Mask filter

Unsharp Mask	
	OK Reset Preview
Amount: 50 %	
Radius: 0.5 pixels	
Threshold: 0 levels	

Photoshop

• Resize/crop image and save it for the web (jpg format)

Image Size 🔀	
Pixel Dimensions: 2.44M (was 36.0M) Width: 800 pixels Height: 533 pixels Auto Occument Size: Width: 2.667 Inches Width: 1.778 inches Resolution: 300 pixels/inch Scale Styles Constrain Proportions Constrain Proportions Resample Image:	Crop Cancel

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Image Comparison



Before



After

– Useful links

- Astrophotography guide for EOS digital http://www.canon.co.jp/Imaging/astro/index-e.html
- Canon EOS 300D modification http://ghonis2.ho8.com/rebelmodnew.html
- Russian FW hack for the 300D http://satinfo.narod.ru/en/
- Photoshop for astrophotographers http://www.astropix.com/PFA/PFA.HTM
- DSLR Focus

http://www.dslrfocus.com/

• MaxDSLR

http://www.cyanogen.com/products/maxdslr_main.htm

Thank you very much!!! Thank Clear skies!!!