

Full Disk Lunar Images with Earthshine



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Astroblast
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Goal

- Give you information to improve your full disk lunar images
- Based on
 - 400 nights imaging the moon in the last 5 years
 - 2000 hours processing images
 - Award winning **full disk lunar** images



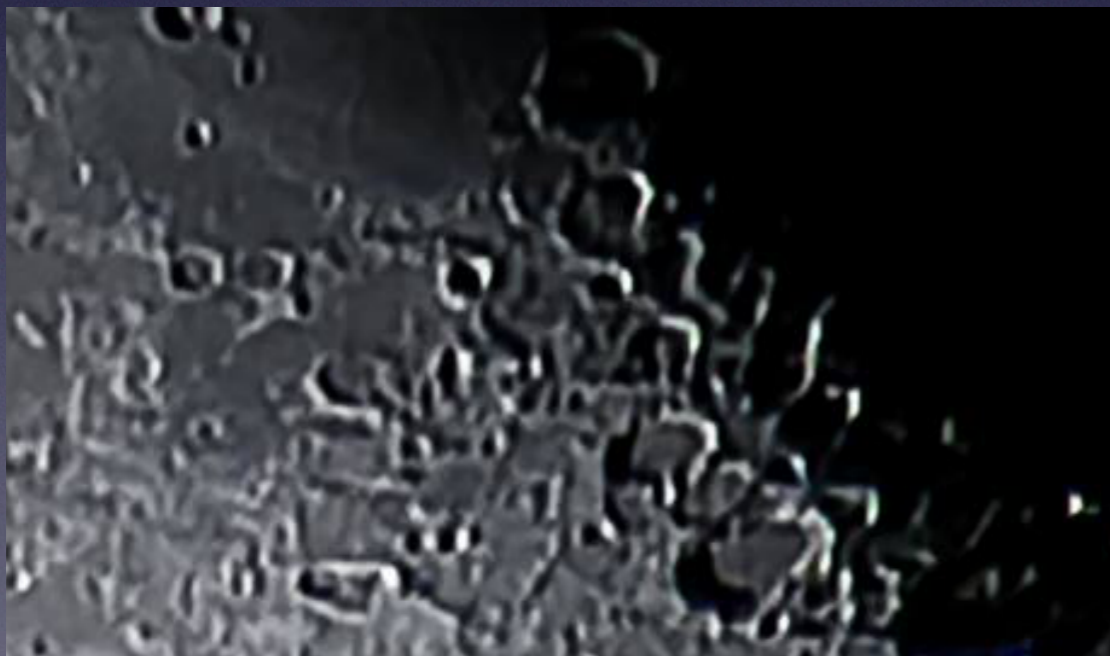
What can go wrong?



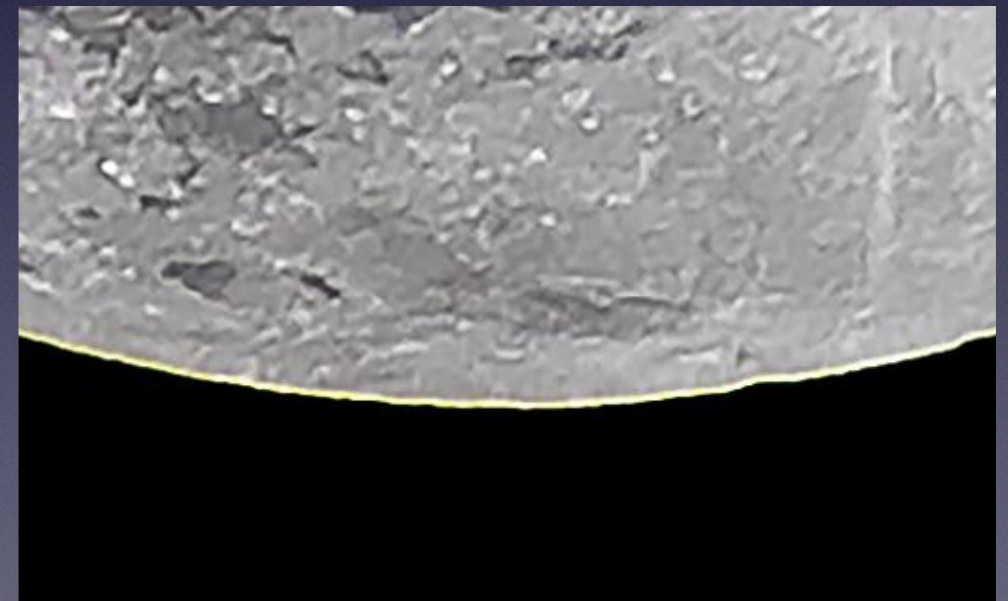
Over exposure is forever



Blurred



Harsh, overprocessed



Limb rings / Onion skins



Lunar Images - Alternatives

- **Video planetary camera with small FOV**
 - **Video small overlapping areas**
 - **Luck image stack each area**
 - **Stitch into composite panorama**
- **Still image camera with wide FOV**
 - **Full lunar disk images + foreground**
 - **Luck image stack**
 - **HDR of lunar disk, earthshine, & foreground elements**



Taking Images - Equipment & Features

- **Manual Good - Auto Bad**
auto exposure, auto focus, & image stabilization don't work reliably
- **Sturdy tripod** - 2 second tap test
- **Good mount Stability for Long Exposures and Focal Lengths**
reduce vibration by rigid mount, reduced weight & vibration like mirror slap and mechanical shutter
- Shoot RAW
- Histogram: expose to the left, at least 25% away from the right edge
- Tracking mount useful but not essential

Start with the camera you have

- DSLRs are great
- **Consider mirrorless for dedicated astro body**
light (easy on the mount) and can use any manual lens



Challenges for Lunar Images

- **Exposure**
- **Crisp Sharp Images**
- **Very High Dynamic Range**
 - **25 stops: Moon to dimmest visual star**
 - **20 stops: Eye**
 - **14 stops: Camera**
 - **10 stops: Screen**
 - **8 stops: Print ($\sim 0.02\%$ of what the eye sees)**
 - **Solutions: HDR stacking and exposure curve stretching**



Lunar Image Process

- **Capture**

- Divide scene into exposure zones
- Shoot burst of images for each exposure
- Shoot reference image with all elements

- **Stack and Process**

- Lucky image stacked of each zone
- Optimize processing for each zone
- Use feathered masks to target sub zones (e.g. terminator, limb)

- **Composite optimized zone layers**

- HDR / focus stacking



Taking Images - Exposures

- **Focal Length**
 - **All Moon $> 800\text{mm}$ with telescope**
 - **Moon + foreground $< 600\text{mm}$ camera lens**
- **Multiple Exposures for HDR - deconstruct scene**
 - **12 - 100 images for lucky image stacking of disk**
 - **5- 10 images for earthshine**
 - **images for nearby planets / stars**
 - **foreground landscape exposures**



Tools for my Moon Images

Sony mirrorless crop sensor

Camera Lenses 12-420 mm



Telescope 1300-5000 mm



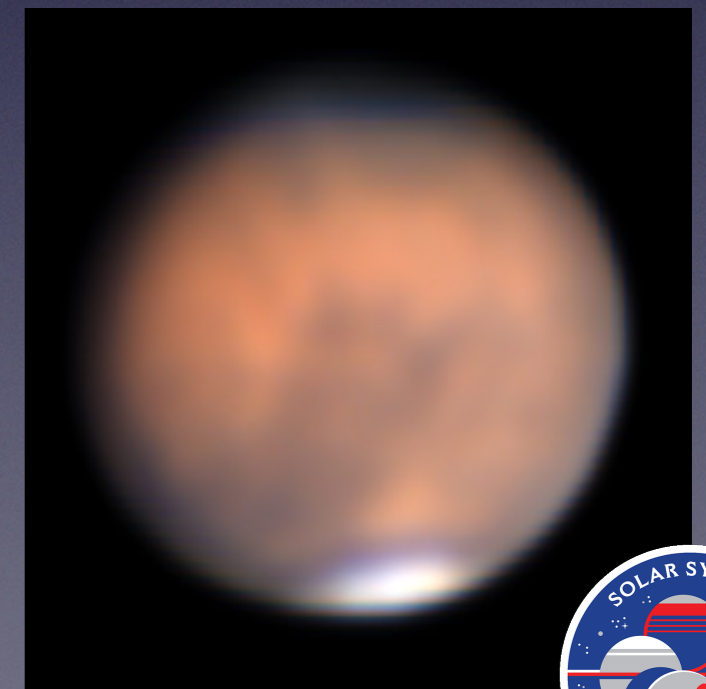
Coat Pocket Kit - Sony RX100 24-70 mm zoom



Stacking

Compositing multiple exposures of the same scene.
Reasons we stack include:

- **Lucky Images - reject worst images**
- **Noise Reduction**
 - **clean low noise image**
 - **resolution enhancement**
 - **deconvolution**
 - **drizzle under sampled images**
- **avoid saturation by summing short exposures**
- **Compress Dynamic Range - HDR stacking of different exposures**
- **Depth of Field stacking**
- **Reject sensor dust**



Example: Stacking to reduce noise and increase resolution

It is difficult to stack full disk images because of air turbulence. It can be done successfully with stackers that warp each frame for best alignment (Nebulosity, AutoStakkert 3)



Example: Stacking to increase Depth of Field



Post Processing: Masking

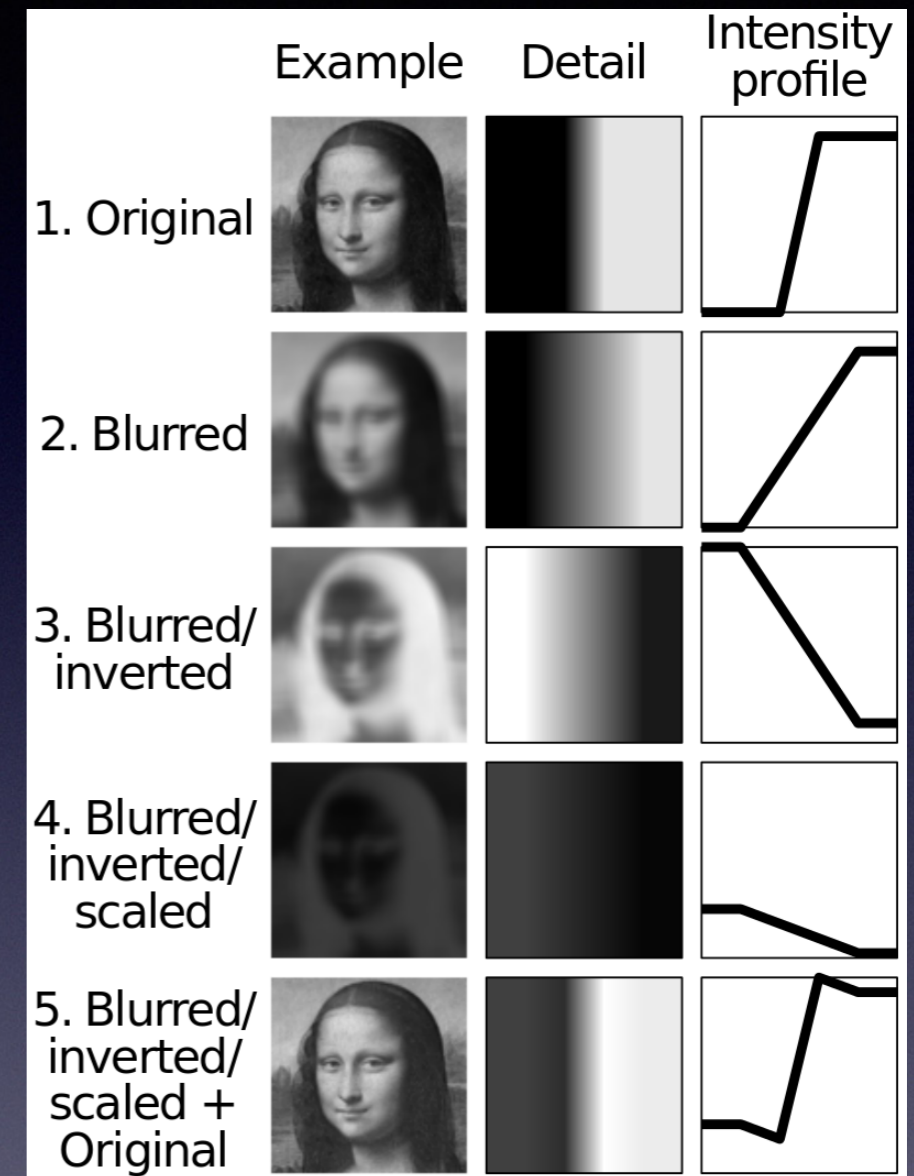


- Avoid over sharpening near terminator and onion skin at limb
- Undersize and feather disk mask
- Avoid terminator, feather to flatly lit high sun region for more sharpening and contrast
- Use tools that give you full control of the mask (not adjustment brush)



Post processing

- Usual suspects:
Gamma, White Balance, Saturation
- Exposure Stretching, masked for effectiveness
- **Resolution Enhancement**
 - requires clean low noise image
 - use **deconvolution or wavelets** not unsharp mask



Unsharp Mask, Credit Wikipedia PD



Example: HDR Stacking

Earthshine in 2 exposures day-lapse



Eclipse with 9 exposure HDR



Earthshine HDR



Conventional 8 exposure HDR by Jerry Lodriguss



Earthshine 2 exposures + Grey Goo



APOD March 20, 2015 Dylan O'Donnell



Earthshine Layer



Earthshine + goo for HDR stack



Processed Crescent



Day-lapse Crescent with Earthshine

Grey goo is hidden when crescent and earthshine are one day apart

Earthshine layer must be resized to account for lunar distance



Resources



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- **A visual tour of a dozen ways to shoot the Moon**
<http://BadAstroPhotos.com/lunarPhotography.html>
- **Day-lapse Images of Earthshine on the Crescent Moon**
<http://BadAstroPhotos.com/daylapse.html>
- **Getting started in astrophotography?**
<http://BadAstroPhotos.com/gettingStarted.html>
- **DSO Astrophotography without a Telescope**
<http://BadAstroPhotos.com/withoutTelescope.html>
- **Print and Display Astrophotography**
<http://BadAstroPhotos.com/howtoPrint.html>

