

Photographing The Night Sky: An Introduction to Astrophotography

by Mary McIntyre

Summary Notes

Basic equipment you need:

- Camera
- Tripod
- Remote shutter cable
- Intervalometer
- For long imaging sessions, pocket hand warmers & an old sock!

Get familiar with your camera! Read the manual. Then:

- Practice changing settings in the dark or with your eyes closed
- Practice removing & re-attaching the camera to the tripod
- Practice getting the focus right

Settings:

- Lowest f number possible to let in the most light
- High ISO, NO FLASH!
- If using a static tripod, shutter speed depends on focal length

For a rough guide, use the “Rule of 600s”:

$$600/\text{focal length} = \text{length of time in seconds before trailing}$$

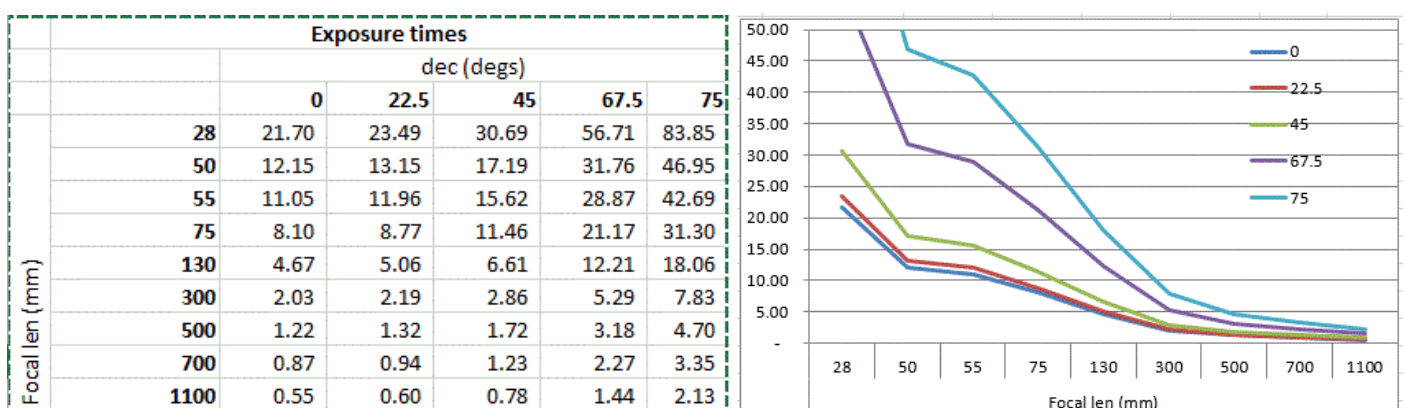
Eg 1: If you are using a length of 50mm:

$$600/50 = 12 \text{ seconds exposure}$$

Eg 2: If you are using a 300mm lens:

$$600/300 = 2 \text{ seconds}$$

More accurately, use this table & graph (produced by Mark McIntyre):



Shooting the Photos:

- Set camera to RAW for long exposures. If no RAW option then chose highest quality jpeg
- Use remote shutter cable or intervalometer if possible
- If you can't use a shutter cable, then utilize the timer delay function to allow the camera to stop shaking before the shutter opens
- Take lots of test shots first and review to check for position & star trailing, etc
- If you're imaging for a long time, prevent dew from forming on the lens using the stock and hand warmers

Shooting Constellations:

- Use highest ISO setting to do your test shots & get framing correct
- Select best ISO for your light levels. Lower if there is a lot of light pollution or a Full Moon, higher if dark sky site
- Select shutter speed according to position of constellation;
Remember – you can shoot longer the closer you are to Polaris
- Review photos to check for star trailing

Shooting Conjunctions:

- The same as shooting constellations
- Planets may look like small stars, but remember:
 - Mercury is 48 million miles away
 - Venus is 160 million miles away
 - Jupiter is 365 million miles away
 - Saturn is 745 million miles away
 - Ceres is 150 million miles away
 - Vesta is 110 million miles away

And they are in your photograph!!!

Shooting The Milky Way:

- For best results, you need as dark a sky as possible
- Long exposures are better, so if you have a static tripod, stacking multiple images & stacking will help to bring out detail
- If possible, use a tracking tripod or piggy-back on your telescope mount
- Good processing techniques will help to make the best of your shots
- Remember; some regions are not visible from the UK

Shooting Star Trails:

- Decide on your framing; Polaris at centre?
- You can do one long exposure at low ISO but you need a very dark site and the resulting image will still be washed out
- Better to take lots of 30 second (or 15 if that's your max) exposures on continuous shooting then use free software such as StarStax to stack them together
- If you save the intermediate files, you can make a timelapse video

Shooting Satellites:

- Visit www.heavens-above.com or download a smartphone app to find out which satellites and Iridium flares are visible from your location
- ISS information is general, but Iridium flares are very location specific, so make sure you have the location set correctly
- Magnitudes: negative numbers are higher. Each order of magnitude is 2.5 x brighter than the previous one
 - Brightest star, Sirius, is mag -1.5, Full Moon -13, Sun -27
 - Brightest Iridium flares are around mag -8.5!
- Iridium flares:
 - Depending on background lighting levels, ISO setting will vary from 400 – 1600 (do test shots!)
 - Exposure time also varies depending on flare magnitude:
 - Mag 0 to -2.5 - 30 seconds
 - Mag -3 to -4.5 – 40 seconds
 - Mag -5 to -7 – 50 seconds
 - Mag -7+ - 60 seconds
 - Try to time it so the peak of the flare is in the middle of your exposure time
- International Space Station & Satellites:
 - If the sky is dark enough, you can do a single exposure of between 60 – 90 seconds, longer if you have a wide angled lens
 - If the background light is too bright, eg, twilight, you can take a sequence of 15 second shots and use StarStax to stack them together. But this method will leave small gaps because the ISS is moving so fast

Shooting Meteors:

- Meteors are random, and may occur at any time
- Best chance of photographing them is during a meteor shower
- Point camera 45 degrees up, at least 45 degrees from the radiant
- Keep ISO as high as light conditions will allow, shoot continuous 20 – 30 second exposures
- Try to record times of meteors you see to assist you later

Principle Annual Meteor Showers:

- Quadrantids January 1st – 6th
- Perseids July 17th – Aug 24th
- Orionids October 14th – 31st
- Geminids December 7th – 16th

Shooting Aurora:

- Faint aurora displays happen quite often from Oxfordshire!
- Download an aurora notifier app for your phone (Aurora Alert is brilliant) or monitor www.spaceweather.com
- Point your camera north, and shoot around ISO-800 or 1600 for between 15 and 30 seconds. Review your shots to check exposure level, then shoot on continuous
- Leave your camera and let eyes become dark adapted so you can see the faint aurora as well as shooting it
- Creating a timelapse video will show movement of the aurora

Shooting Noctilucent Clouds:

- Only visible in northern hemisphere from mid-May until mid-August; peak activity during June & July
- Visible low in NW 60-90 mins after sunset or NE 90-60 mins before sunrise
- ISO-800 or 1600 depending on light levels, exposure times vary drastically, so do test shots
- NLCs make very interesting timelapse videos, but can be challenging to do due to constantly changing light levels

Optical Phenomena:

Lunar Optical Phenomena:

- ISO-800 or 1600, and between 1 second and 5 seconds exposure to bring out faint details
- Post processing will really help to enhance the faint details, whilst tonight down the brighter parts

Solar Optical Phenomena:

DO NOT LOOK AT THE SUN THROUGH YOUR VIEW FINDER!

- Focus on clouds away from the Sun, then swing the camera back round
- F-stop needs adjusting to around 7 or 8, otherwise the image will be very over exposed
- ISO-100 & fastest shutter speed possible
- Image will still look over exposed, but post processing will correct it

For more information about optical phenomena, visit www.atoptics.co.uk

This will be your new favourite website!

Shooting Lightning:

At Night:

- Keep an eye on weather forecasts
- Focus during the day on a distant cloud. If you can't do that, you'll have to guess!
- Set the ISO to 100, shutter speed between 15 – 30 seconds, depending how often the flashes are
- Shoot on continuous

Daytime Lightning:

- Much trickier to do successfully
- Best to shoot lots of short videos then use software to extract the frames which contain lightning
- Will generate a LOT of data so try to delete unwanted videos as you go

<http://www.lightningmaps.org/realtime> helps you to watch for approaching storms & chose your best position/framing

Shooting a slightly distant storm is often better than one that's directly overhead

Shooting With a Zoom Lens:

- All the principles are the same, except you need to reduce your shutter speed accordingly (remember your rule of 600s!)
- Can make solar filters to fit over the lens, or use an ND500 neutral density filter

Shooting With a Bridge Camera:

- Features will vary from camera to camera
- Very good for doing wide field night sky shots & daytime optical phenomenon
- Can utilize the optical and digital zoom for close up Moon and Sun photos
- Cannot easily image through telescope with them
- Not as much manual control over the settings
- When choosing a camera, beware that a larger zoom doesn't necessarily mean a bigger picture; it also depends on chip size

Tips for using a Nikon Coolpix (from David Blanchflower):

- Daytime Moon shots, "Landscape" mode works well, at ISO-100
- Night time Moon shots, "Night Landscape" mode works well, also ISO-100
- For solar filter pictures, use "Auto"

Tips for using a Canon SX50 (from Angela Garrod):

- Tv (shutter priority) setting for most things
- For exposures longer than 1s it auto reverts to ISO-80 so post processing is important

Tips for using a Lumix (from Dr. Steve Wainright):

- Lunar & solar imaging, ISO-100 and maximum zoom
- Constellation shots, use "starry night" mode if you have it, otherwise as long an exposure time as possible

Shooting With Camera Attached to Telescope:

- 3 ways to do this:
 - Afocal Photography
 - Holding a camera & lens up to an eye piece and taking a photo
 - Eyepiece Projection
 - Lens removed from camera body & camera attached to eye piece using a T-ring
 - Prime Focus Photography
 - Camera body attached directly to telescope. No lenses, no telescope eyepieces. Sometimes a 2x Barlow is needed for focus

Afocal Photography:

- Can use a mobile phone to do this. Hold manually or buy phone adapter
- With compact camera hold the camera manually or use a Steady Pix for a better result

Eyepiece Projection:

- You will need:
 - DSLR camera
 - T-ring
 - Eye piece which is threaded
 - Easy to use filters with this method as they screw into the eyepiece

Prime Focus Photography:

- Attach camera either before or after the diagonal
- The most effective way of producing better quality images
- A 2x Barlow may be needed in the imaging train
- Use a Bahtinov mask to achieve perfect focus on stars
- Use a Hartmann filter to achieve focus on the Sun & Moon

Prime Focus Lunar Photography:

- Moon is the easiest imaging target so a great place to start!
- ISO & shutter speed will vary depending on Moon phase, but if mount is static, keep shutter speed as fast as possible
- Over expose to bring out earthshine during crescent phase
- Craters are best photographed during half to gibbous phase
- Different basalt colours best seen near Full Moon but be careful of over exposing the brightest parts

Prime Focus Solar Photography:

IMPORTANT SAFETY POINTS

- Never look at the Sun without a filter in place
- Project onto a piece of card when aligning
- Keep the view finder covered once aligned to prevent accidental eye damage
- Make sure the filter can't blow or fall off

Shooting Solar Images:

- Use a black blanket to cover your head when trying to focus
- Use a sunspot to focus on
- Exposure times will vary depending on the telescope, but around ISO-800 works well for me
- If mount is static, keep shutter speed as fast as possible to prevent motion blur (increase ISO if necessary)

Prime Focus Deep Sky Photography:

- Set camera to highest ISO setting to test framing, etc
- Shoot on highest ISO the sky conditions allow
- Always shoot in RAW
- If tripod is static, use the rule of 600s to estimate shutter speed, then do lots of test shots
- You will get infinitely better results with an equatorial tracking mount

Stacking:

Software is used to combine lots of duplicate images together to create a more detailed photograph

- For the Sun, Moon & planetary images
 - Autostakkert! 2
 - Registax 6
- For widefield or deep sky
 - Deep Sky Stacker

Better to stack fewer, high quality images

Stacking With Registax & Autostakkert:

- Can stack a series of still frames or a video sequence
- Magic Lantern gives you more control over video function
- Not all camera RAW files are compatible, so batch process to convert them to TIFFs

Stacking With Deep Sky Stacker:

- Recent update means it can now stack RAW images
- Use calibration frames
- Make sure you regularly check for upgrades

Calibration Frames:

- Dark Frames
 - Removes noise from the camera
 - Take about 50 identical shots with the lens cap on at the end of your session, so temperature is the same
 - A master dark is produced & subtracted from your pictures
 - Can produce a library of darks over time so record the temperature!

- Flat Frames
 - Remove optical aberrations from the imaging train, such as vignetting, and removes dust & scratches
 - Take a series of images of an evenly illuminated white surface, with camera in exactly the same position
 - Start with ISO400 or lower for approx. 0.2 to 2.5 seconds
 - Review the histogram; aim for around 50% brightness, then take 30 – 50 shots
 - A master flat is produced & subtracted from the final image

Basic Processing:

- Windows Photogallery has some nice features
- Fast Stone Image Viewer is way superior, and free to download
- Irfanview also has nice features
- Adobe Lightroom is great for archiving and batch processing, which is very useful!

Basic Processing; What Do I Need To Do?

- Constellations/Widefield
 - Adjust the contrast to darken the sky
 - Adjust the highlights to enhance stars
 - Adjust the gamma levels to enhance the brightness
 - Adjust the white balance to correct for light pollution
- Lunar Processing
 - Adjust the contrast to darken the maria regions
 - Adjust the highlights to enhance craters & highland areas
 - Adjust the colour saturation to enhance the basalt regions

Advanced Processing:

Photoshop is a popular choice

Useful Photoshop plug ins:

- RC Astrotools
- Gradient Xterminator

Other powerful image processing programmes:

- Maxim DL
- Pixinsight

You Tube tutorials & online blogs are extremely helpful!

Planetary Imaging With a DSLR:

- You need moderate sized telescope
- Use Backyard EOS or Backyard Nikon
 - Takes a video of the 10x live view screen on your camera
 - You then stack the best individual frames

Storage/Sharing:

- Find an online image hosting/photo sharing site
 - Eg. Flickr, 500pix, Astrobin
- Include all the details of equipment used, exposure times, processing, etc. Also create albums for everything to help you find things again later (This is very helpful later!)
- Online astronomy community very helpful, so use social media
- Submit your images to the BAA, SPA, etc.
- Don't delete your old photos when you've improved; it's good to see your progression

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