



Deep Sky Imaging

CAA
18th July 2012
by
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www.astronomylog.co.uk

Telescopes & Mounts

Which telescope?

- Start with a small aperture telescope
- Most DSO are quite large
- Not one size scope suits all objects
- Refractors are easy to use
- ED Doublet Refractors offer good value for money



Cameras

DSLR vs CCD Imagers



Canon, Nikon, Sony etc



Atik, Starlight Xpress, SBIG, QSI

Cameras

DSLR vs CCD Imagers

DSLR Advantages

- Relatively Cheap
- Useable for other purposes
- Big chip size (large FOV)
- No computer necessary
- Colour images in a single shot

DLSR Disadvantages

- Noisy (not the sound they make, but the noise in the image – uncooled)
- Limited red sensitivity through IR blocking filter
- Hard to focus using viewfinder or LCD screen
- Short battery life



Cameras

DSLR vs CCD Imagers

CCD Advantages

- Low noise due to sensor cooling
- Astronomy optimised
- Can be used with wide range of filters
- No shutter noise

CCD Disadvantages

- Expensive (filter wheels and filters if you choose a mono version)
- Computer required for operation
- Limited use
- Smaller CCD chips = smaller FOV



Cameras

Mono CCD vs Colour CCD

Mono Advantages

- Greater sensitivity (no colour Bayer matrix)
- More adaptable (better for Ha imaging)
- Higher resolution
- Great for beginners, mono images look good!

Colour Advantages

- No extra costs of filter wheels and filters
- Less final processing required



Attaching the camera

DSLR

T-ring

1.25" or 2" nosepiece



CCD

1.25" or 2" nosepiece

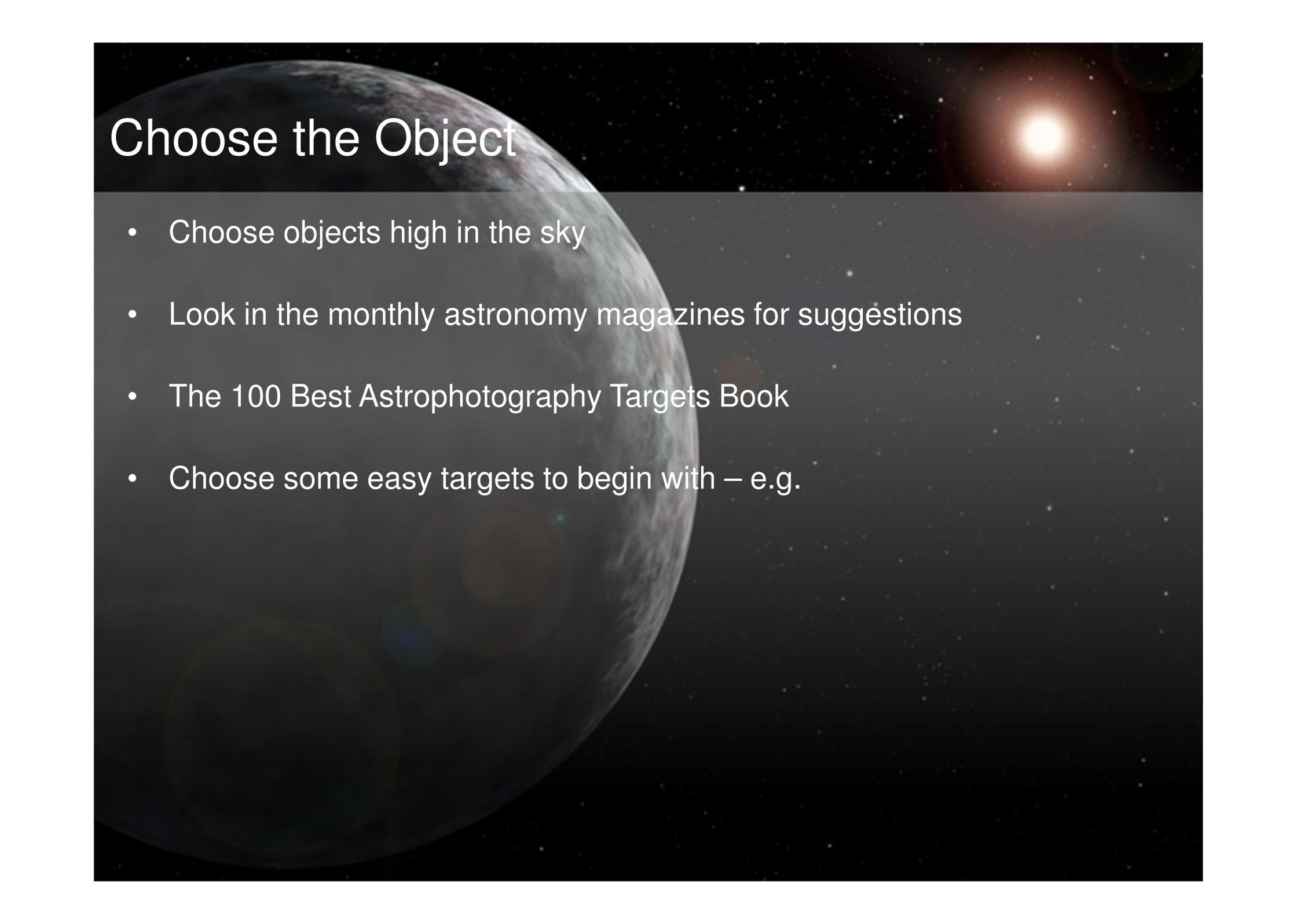
Can't focus, not enough
back focus, use an
extension tube.



Overview

The 6* F Program

- * **F**ind the object - (planetarium software, GoTo mounts)
- * **F**ocus - (DSLR – live view, Bahtinov masks, focusers)
- * **F**rame – (CCD calculator)
- * **F**ollow – (RA tracking, Polar Alignment, Autoguiding)
- * **F**ilm – (Exposure, RGB, Filters, Binning, Dark & Flat Frames)
- * **F**inish – (Calibrate, Stack, Align, FITS Liberator, Photoshop)



Choose the Object

- Choose objects high in the sky
- Look in the monthly astronomy magazines for suggestions
- The 100 Best Astrophotography Targets Book
- Choose some easy targets to begin with – e.g.

Find the Object

M27 – Dumbbell Nebula



Find the Object

M31 – Andromeda Galaxy



Find the Object

M33 – Triangulum Galaxy



Find the Object

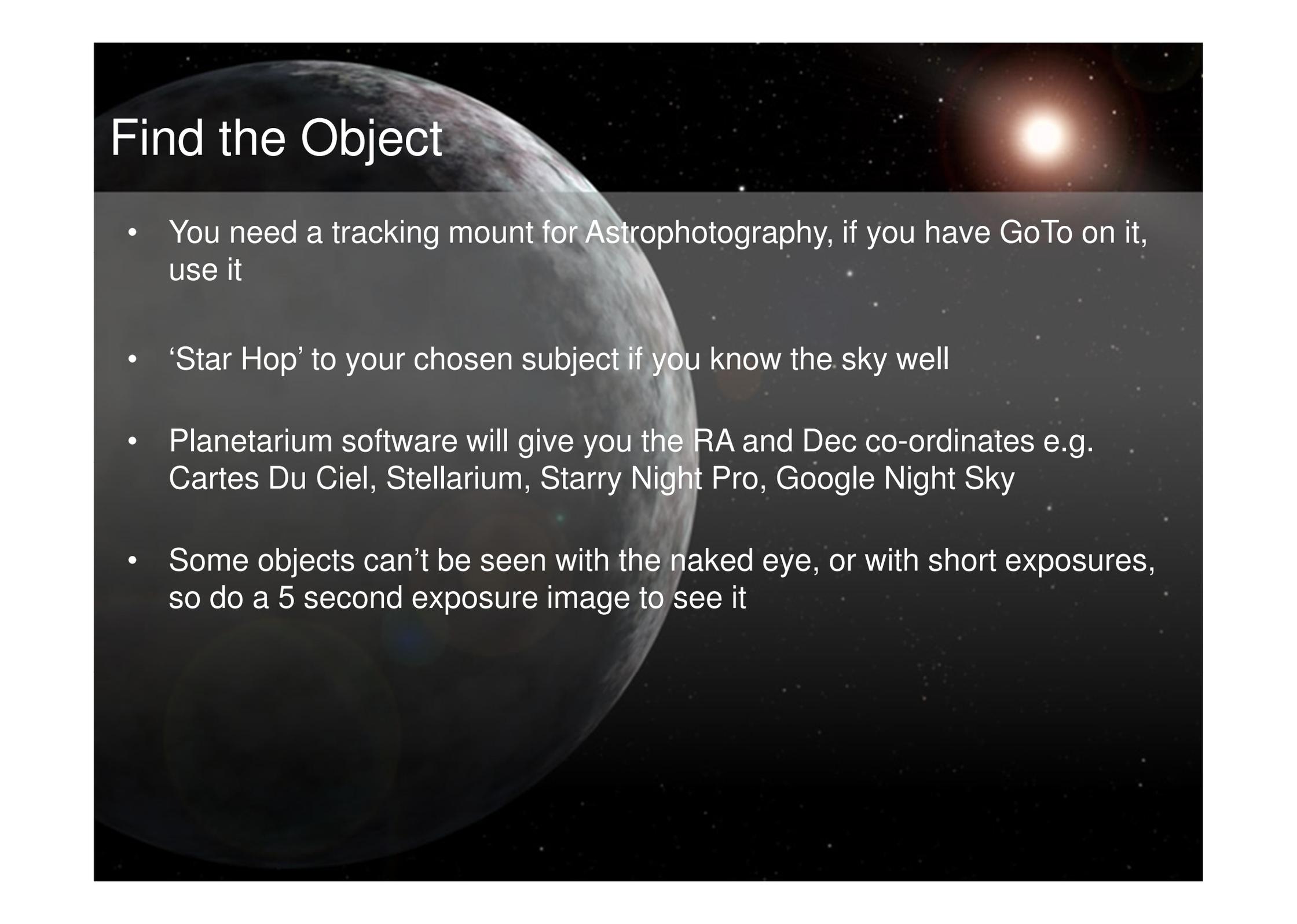
M38 – Open Cluster



Find the Object

NGC2024 – Flame & Horsehead Nebula





Find the Object

- You need a tracking mount for Astrophotography, if you have GoTo on it, use it
- 'Star Hop' to your chosen subject if you know the sky well
- Planetarium software will give you the RA and Dec co-ordinates e.g. Cartes Du Ciel, Stellarium, Starry Night Pro, Google Night Sky
- Some objects can't be seen with the naked eye, or with short exposures, so do a 5 second exposure image to see it

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Focus your Object

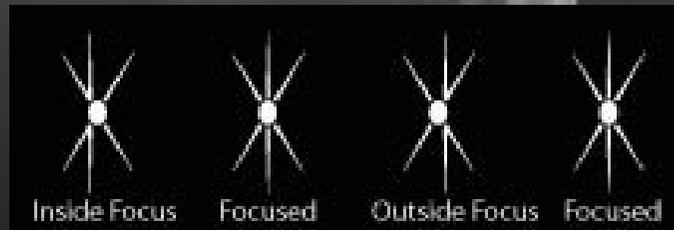
DSLR

Try using the viewfinder

Use 'Live View' on LCD or through PC

DSLR or CCD

Bahtinov Masks



Motor Focusers – DC Motor or Stepper Motor versions

Remember - Temperature changes focus

Overview

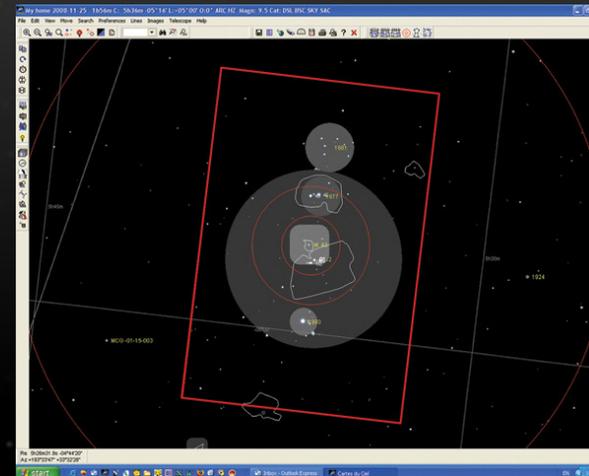
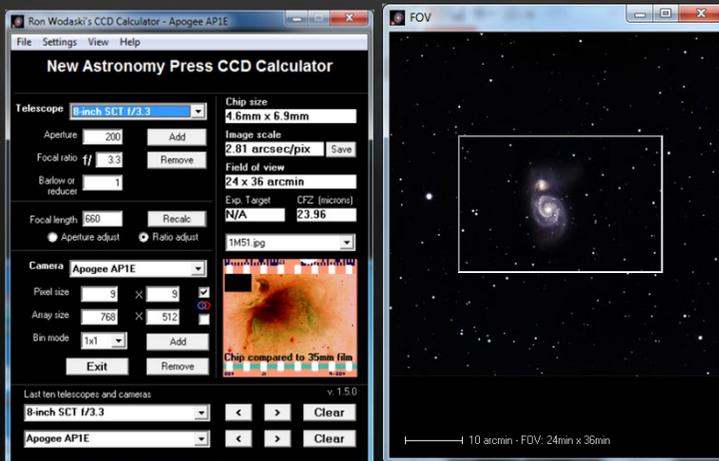
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Frame your Object

- Centre the object on your camera, unless other objects exist in the frame
- Rotate your camera to fit the object in the FOV
- An imaging session may take more than 1 night
- Will the object be too big for your imaging set up? (focal reducer)
- Will the object be too small for your imaging set up? (barlow)

Check it with a free program like Cartes Du Ciel or CCD Calculator

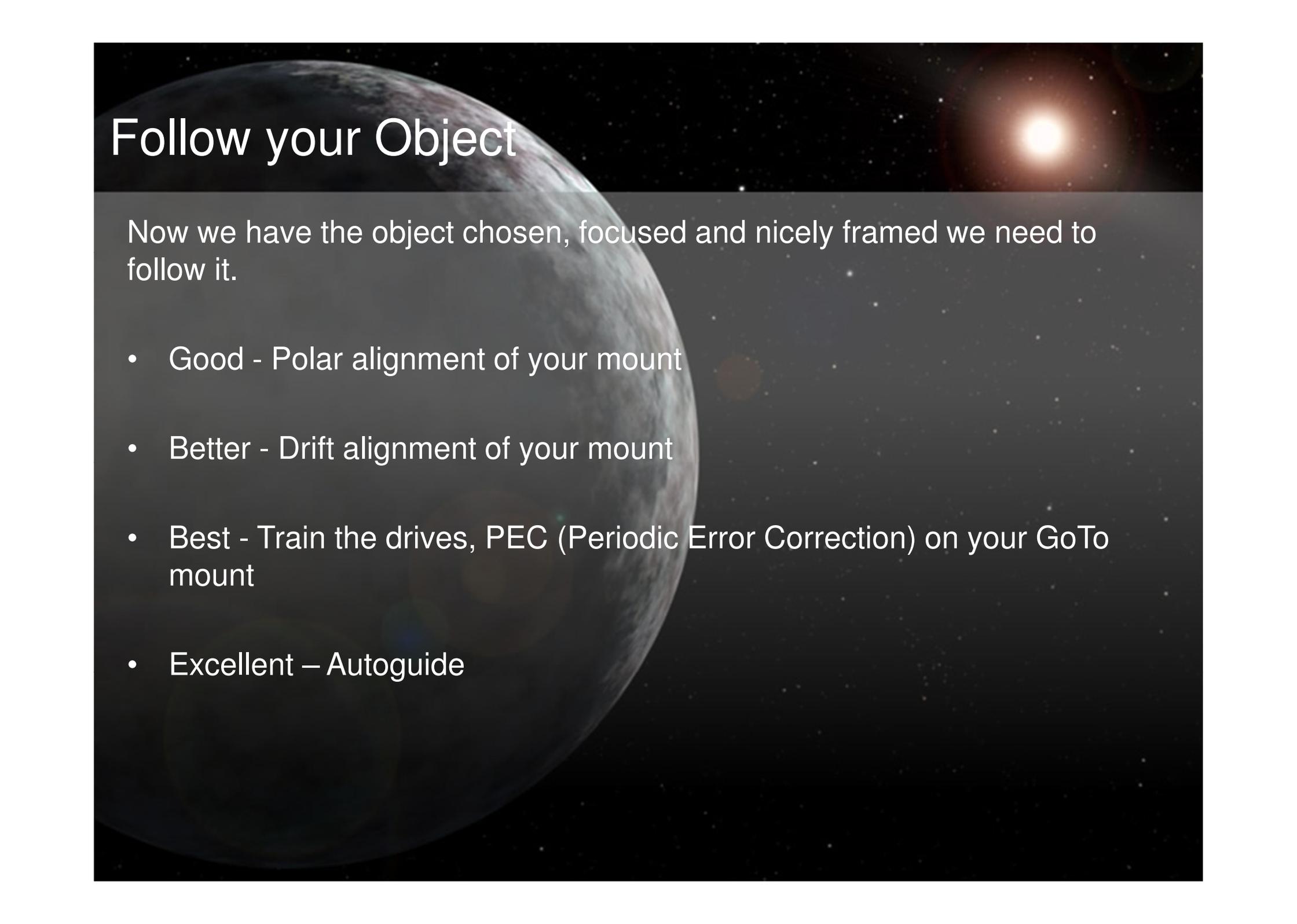


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Follow your Object



Now we have the object chosen, focused and nicely framed we need to follow it.

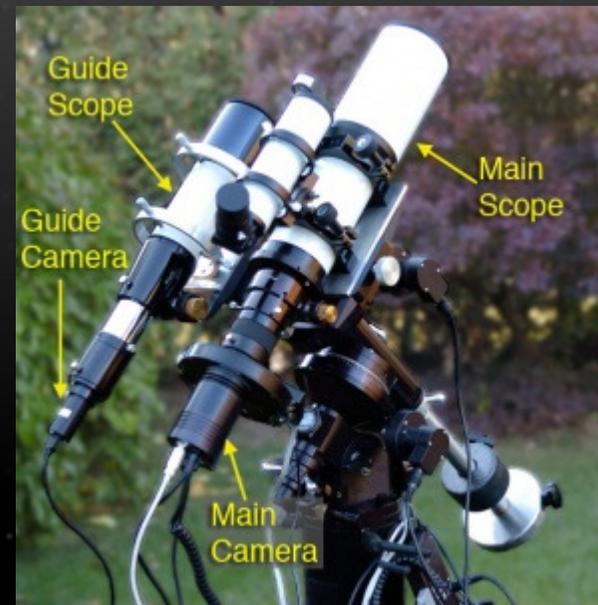
- Good - Polar alignment of your mount
- Better - Drift alignment of your mount
- Best - Train the drives, PEC (Periodic Error Correction) on your GoTo mount
- Excellent – Autoguide

Follow your Object

Autoguiding

Autoguiding uses a secondary CCD camera either connected to another telescope or even finderscope or connected to an off-axis guider, which is used to continuously image a 'test' star.

Any movements of the star on the secondary camera are then relayed to the main mount keeping it on target.



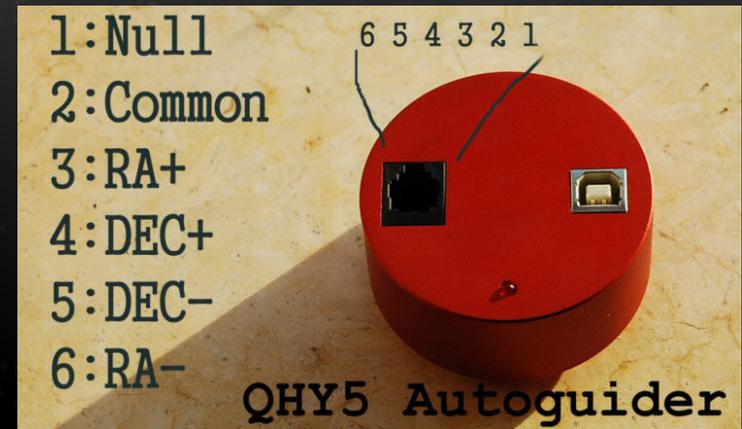
Follow your Object

Autoguiding

Cheap 2nd telescopes are fine, you can even adapt your finderscope.

Usually use your ST4 port on your mount connected to ST4 port on your secondary CCD camera.

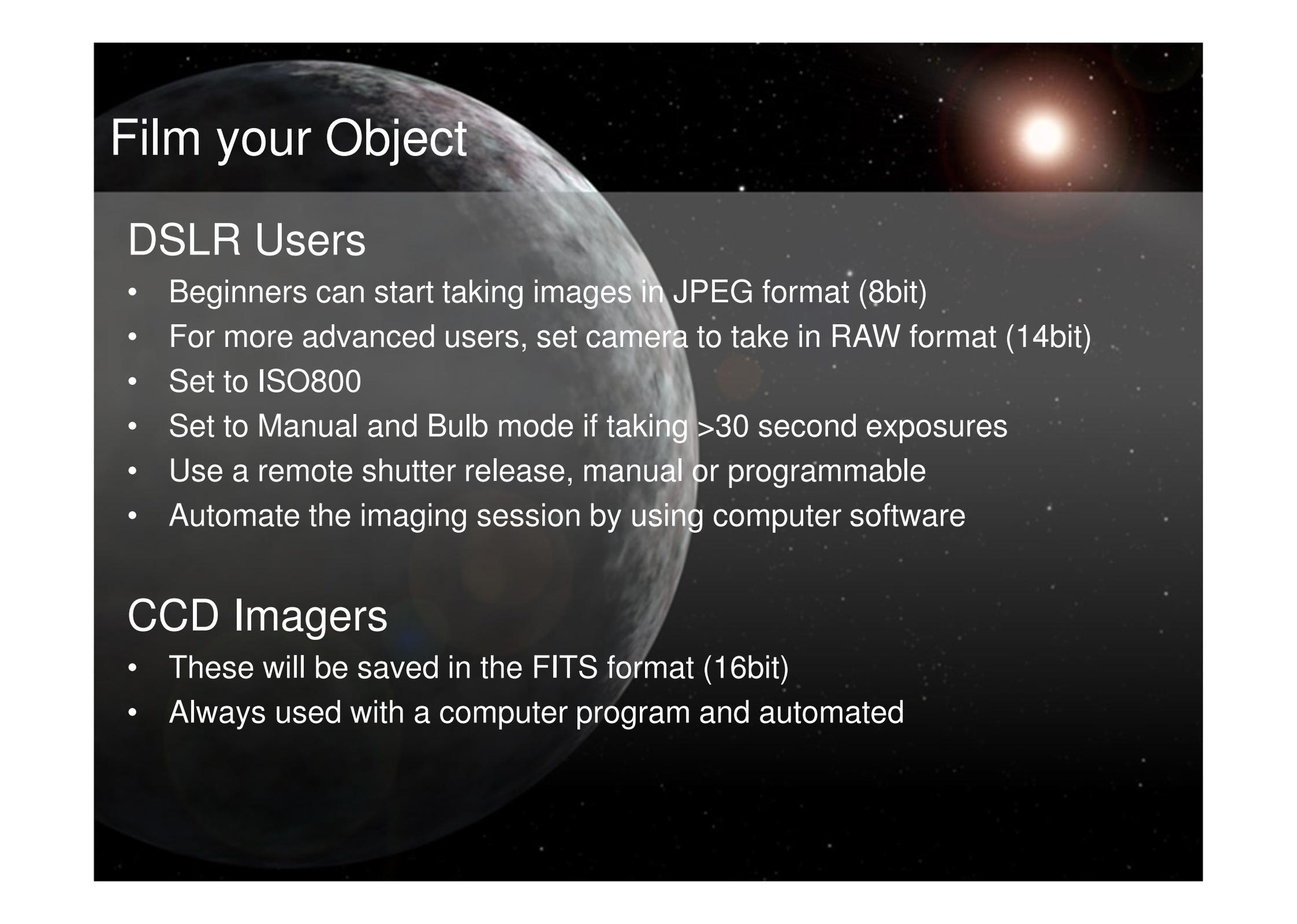
But if you don't have any ST4 ports, you can buy a USB to ST4 port adaptor box to which you can connect your 2nd camera. Or you can autoguide via USB by using a PC program like PHDguiding – which is excellent and free!



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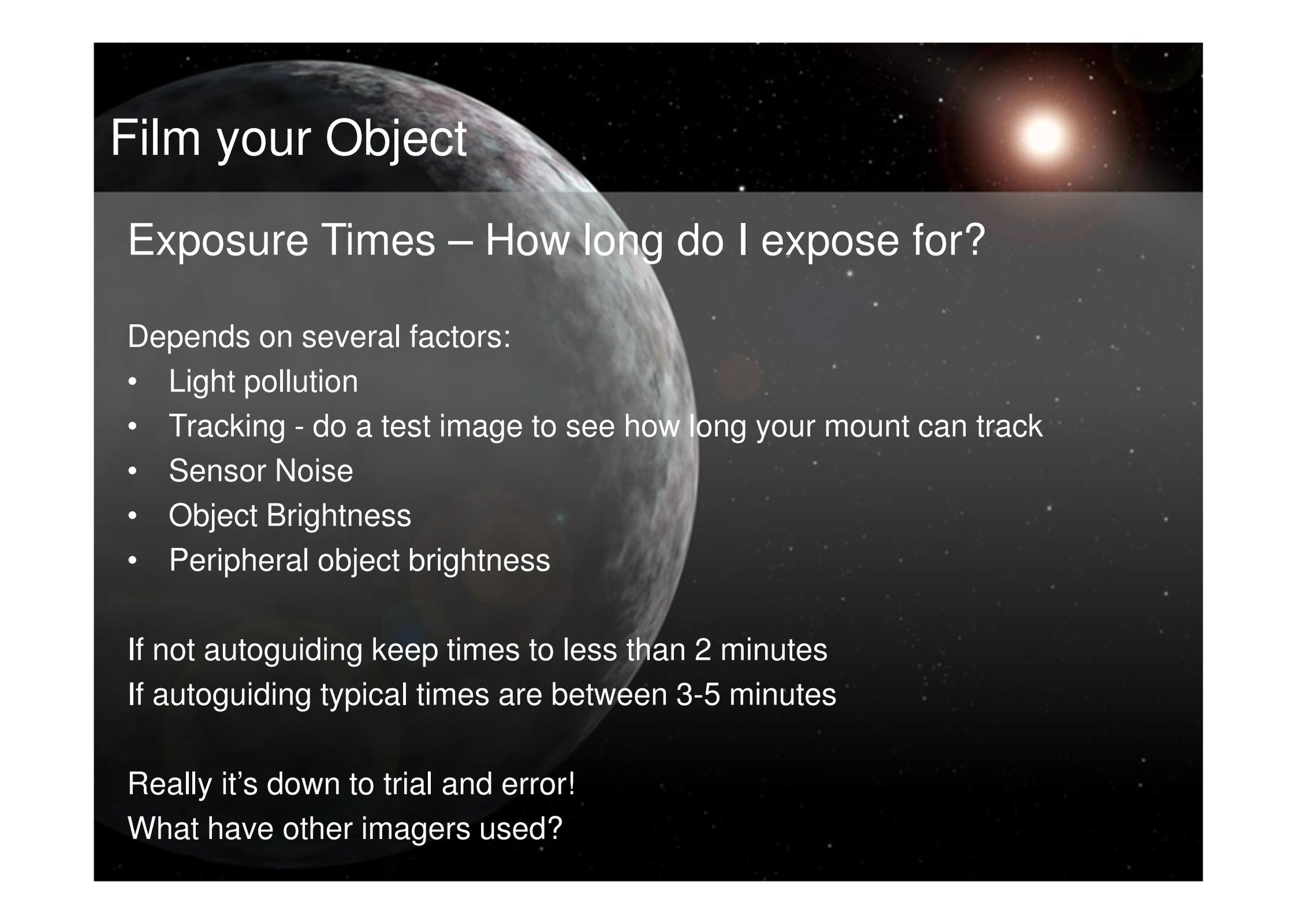
Film your Object

DSLR Users

- Beginners can start taking images in JPEG format (8bit)
- For more advanced users, set camera to take in RAW format (14bit)
- Set to ISO800
- Set to Manual and Bulb mode if taking >30 second exposures
- Use a remote shutter release, manual or programmable
- Automate the imaging session by using computer software

CCD Imagers

- These will be saved in the FITS format (16bit)
- Always used with a computer program and automated



Film your Object

Exposure Times – How long do I expose for?

Depends on several factors:

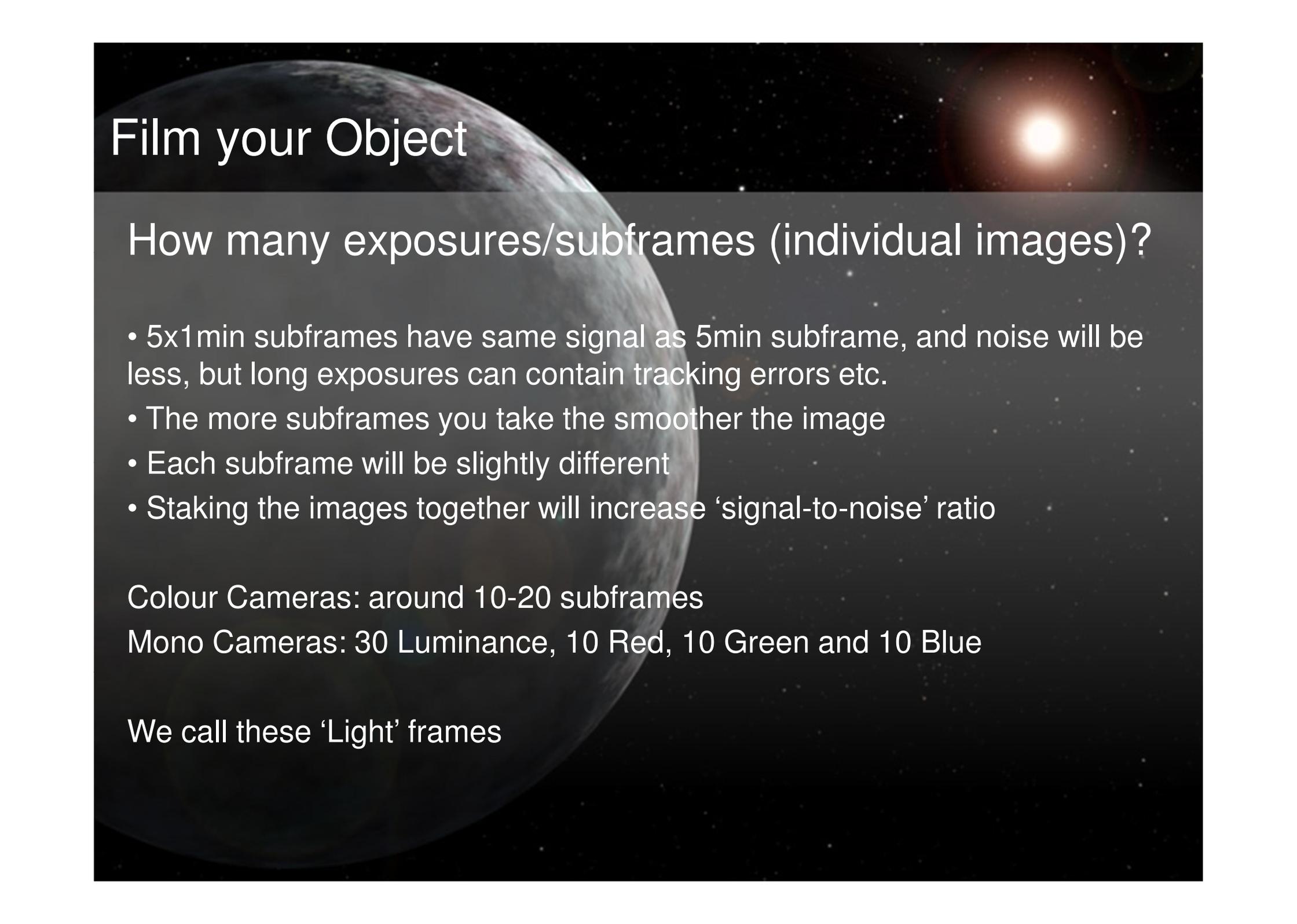
- Light pollution
- Tracking - do a test image to see how long your mount can track
- Sensor Noise
- Object Brightness
- Peripheral object brightness

If not autoguiding keep times to less than 2 minutes

If autoguiding typical times are between 3-5 minutes

Really it's down to trial and error!

What have other imagers used?



Film your Object

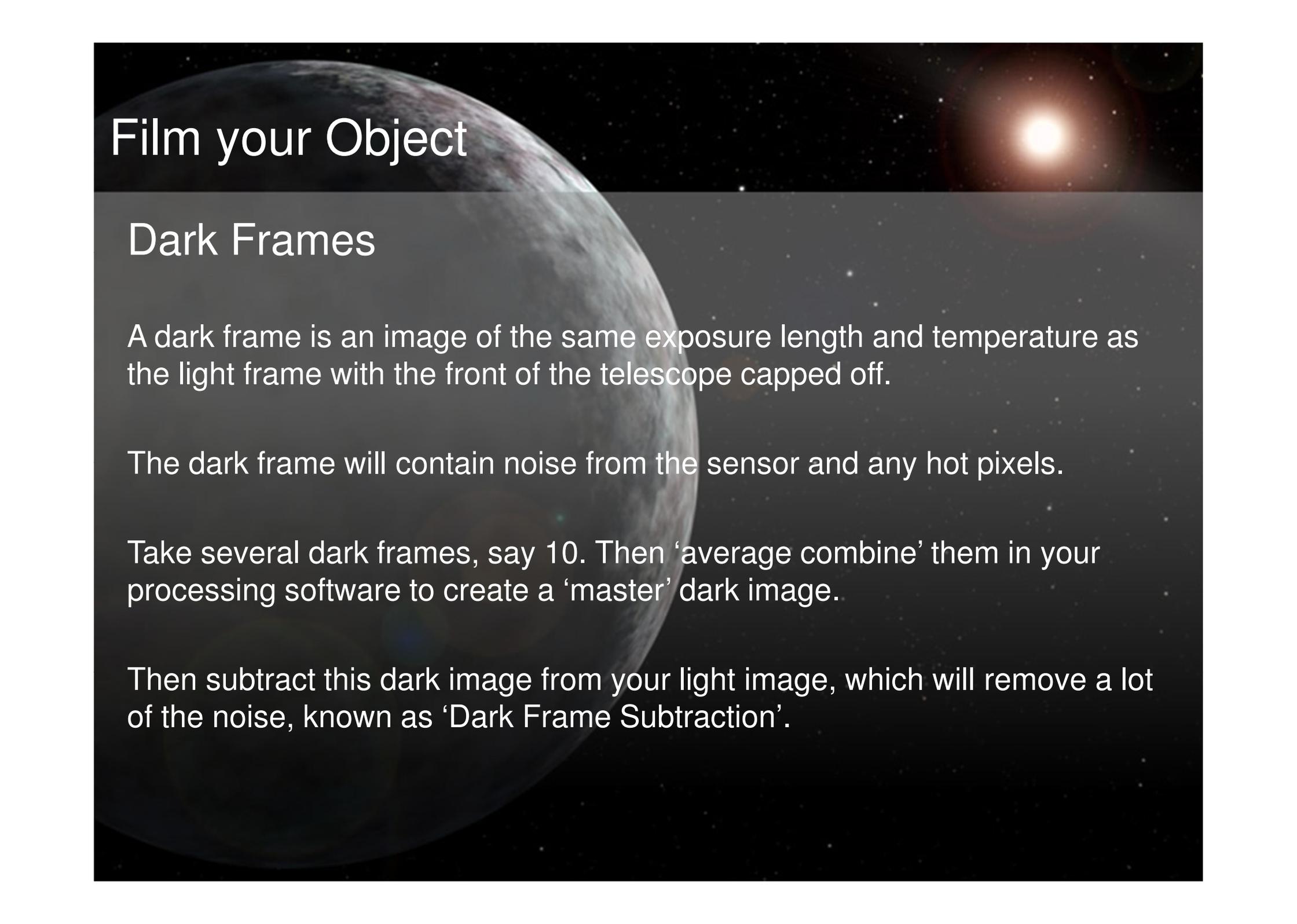
How many exposures/subframes (individual images)?

- 5x1min subframes have same signal as 5min subframe, and noise will be less, but long exposures can contain tracking errors etc.
- The more subframes you take the smoother the image
- Each subframe will be slightly different
- Staking the images together will increase 'signal-to-noise' ratio

Colour Cameras: around 10-20 subframes

Mono Cameras: 30 Luminance, 10 Red, 10 Green and 10 Blue

We call these 'Light' frames



Film your Object

Dark Frames

A dark frame is an image of the same exposure length and temperature as the light frame with the front of the telescope capped off.

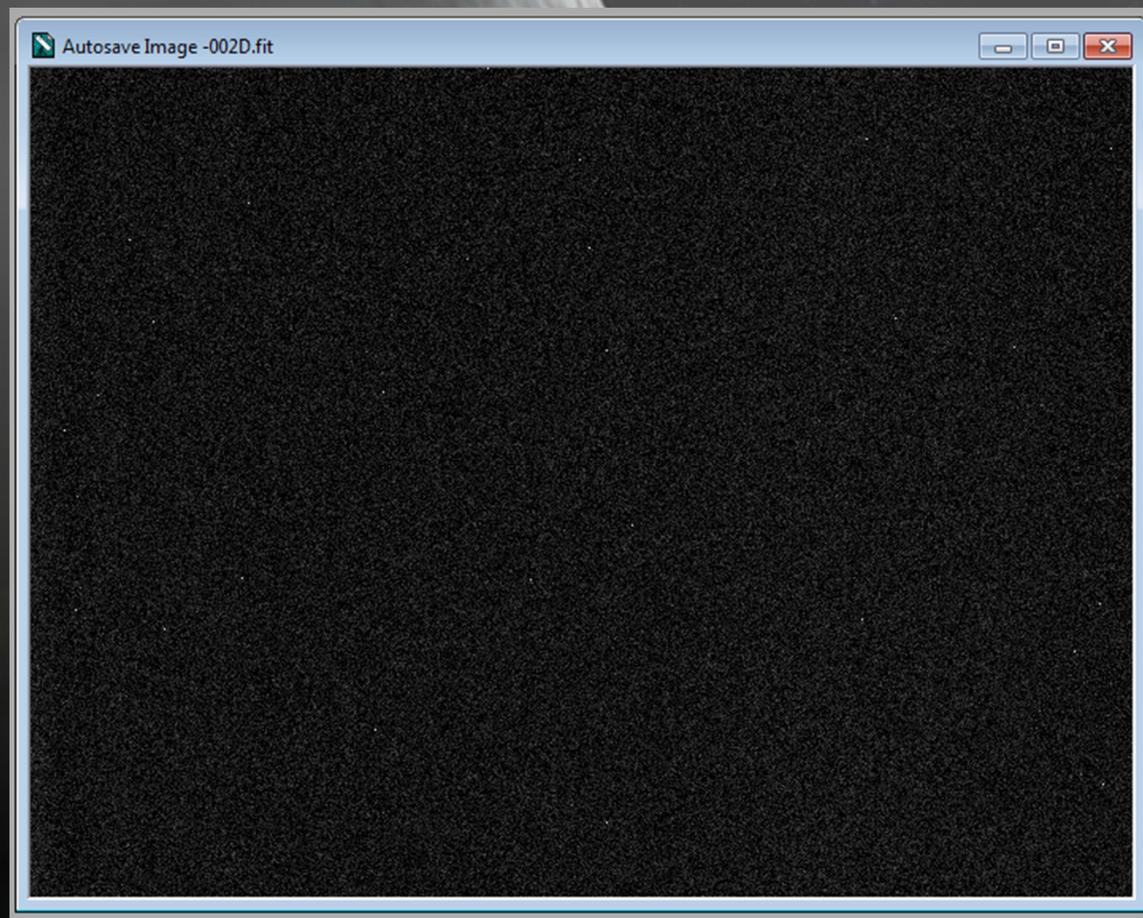
The dark frame will contain noise from the sensor and any hot pixels.

Take several dark frames, say 10. Then 'average combine' them in your processing software to create a 'master' dark image.

Then subtract this dark image from your light image, which will remove a lot of the noise, known as 'Dark Frame Subtraction'.

Film your Object

Dark Frames



Film your Object

Filters

Got a mono camera and want colour images - use filters!

Broadband: Red, Green, Blue and Luminance/IR filter

Narrowband: Ha (Red), OIII (Green), SII (Red, but map to Blue)

Hubble Palette: Red (SII) – Green (Ha) – Blue (OIII)



Astronomik, Baader, Astrodon etc.

Film your Object

Broadband vs Narrowband



NGC7000 – Narrowband



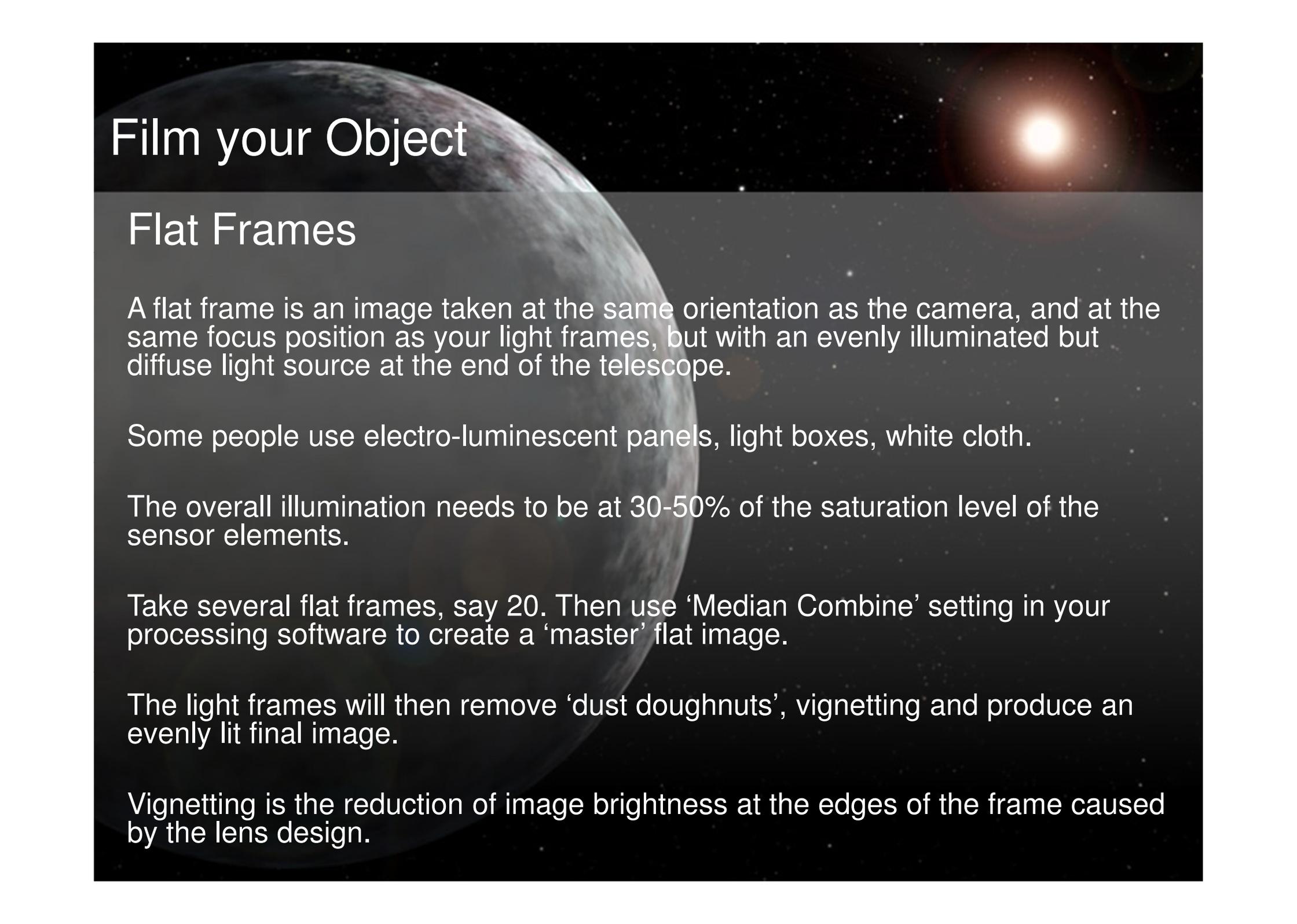
NGC7000 – Broadband & Ha

Film your Object

Filter Wheels

If using filters you need a filter wheel, manual or motorised.





Film your Object

Flat Frames

A flat frame is an image taken at the same orientation as the camera, and at the same focus position as your light frames, but with an evenly illuminated but diffuse light source at the end of the telescope.

Some people use electro-luminescent panels, light boxes, white cloth.

The overall illumination needs to be at 30-50% of the saturation level of the sensor elements.

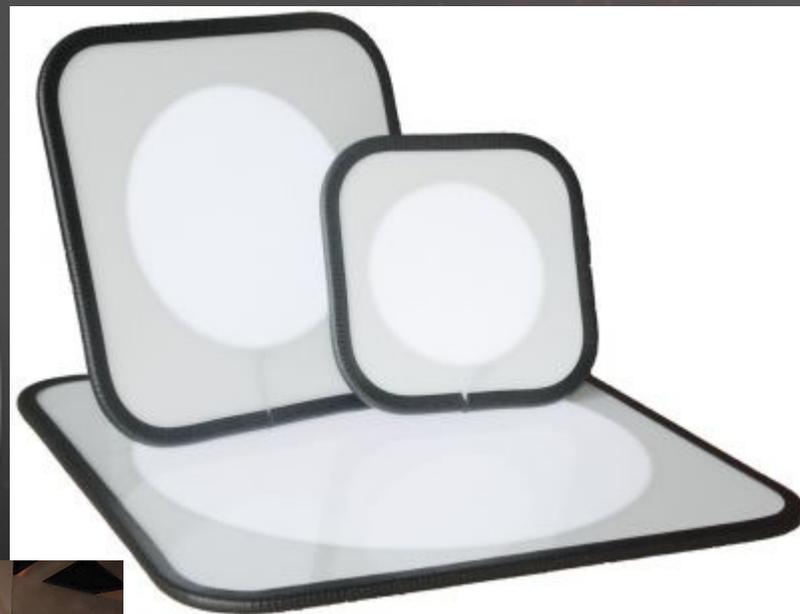
Take several flat frames, say 20. Then use 'Median Combine' setting in your processing software to create a 'master' flat image.

The light frames will then remove 'dust doughnuts', vignetting and produce an evenly lit final image.

Vignetting is the reduction of image brightness at the edges of the frame caused by the lens design.

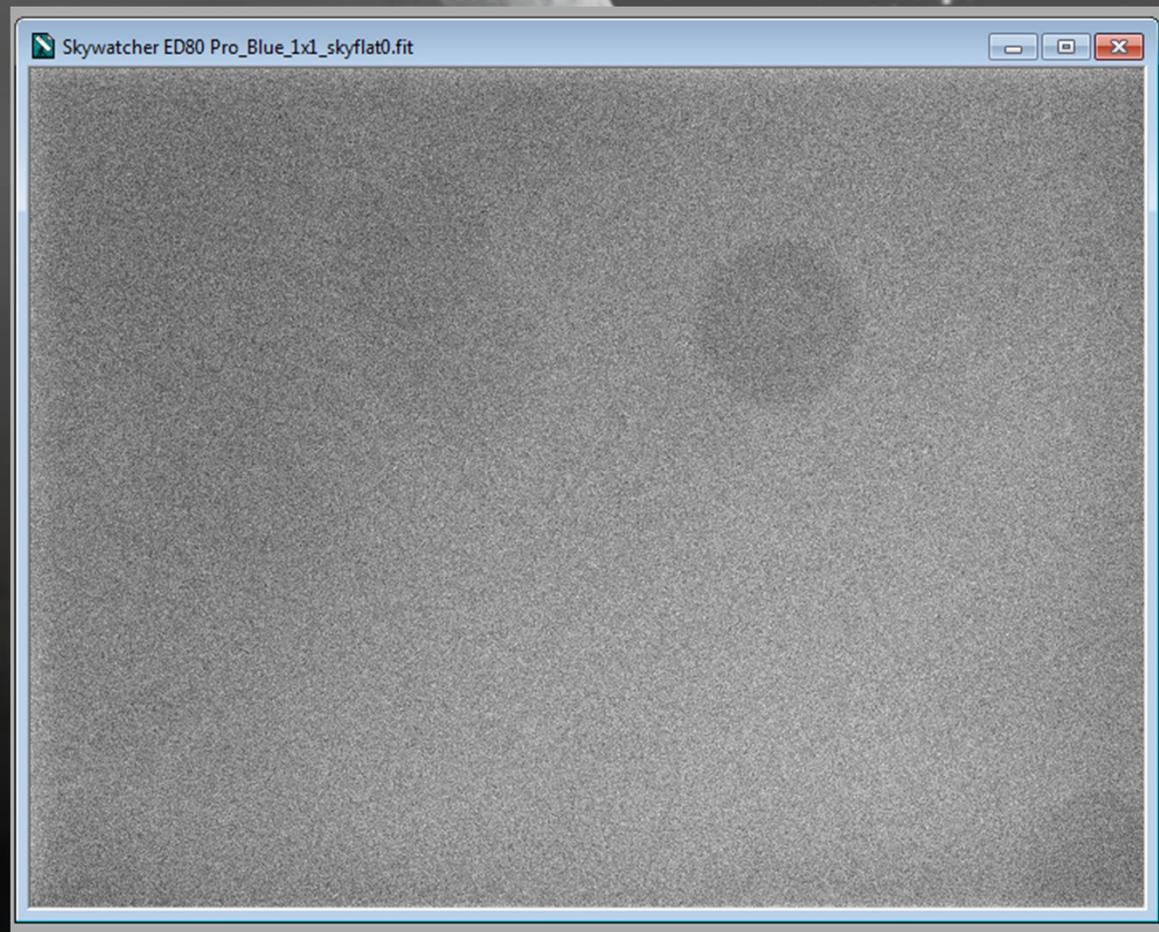
Film your Object

Flat Frames



Film your Object

Flat Frames



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Finish your Object

Image Processing – This is where the work starts!

I use Maxim DL for capture, calibration, stacking and alignment

FITS Liberator to convert the images ready for Photoshop

Photoshop to put the RGB frames together and manipulate the images

1. Discard low grade subframes – bad tracking, clouds, aircraft and satellite trails
2. Calibrate subframes – use dark and flat frames
3. Stack and Align individual LRGB into their groups, stretch, DDP filters
4. Open LRGB frames in FITS Liberator - Auto Levels and Save as TIFF
5. Open LRGB TIFF files in Photoshop
6. Levels, Curves, Sharpen, Reduce Noise, Combine LRGB frames etc.



Finish your Object

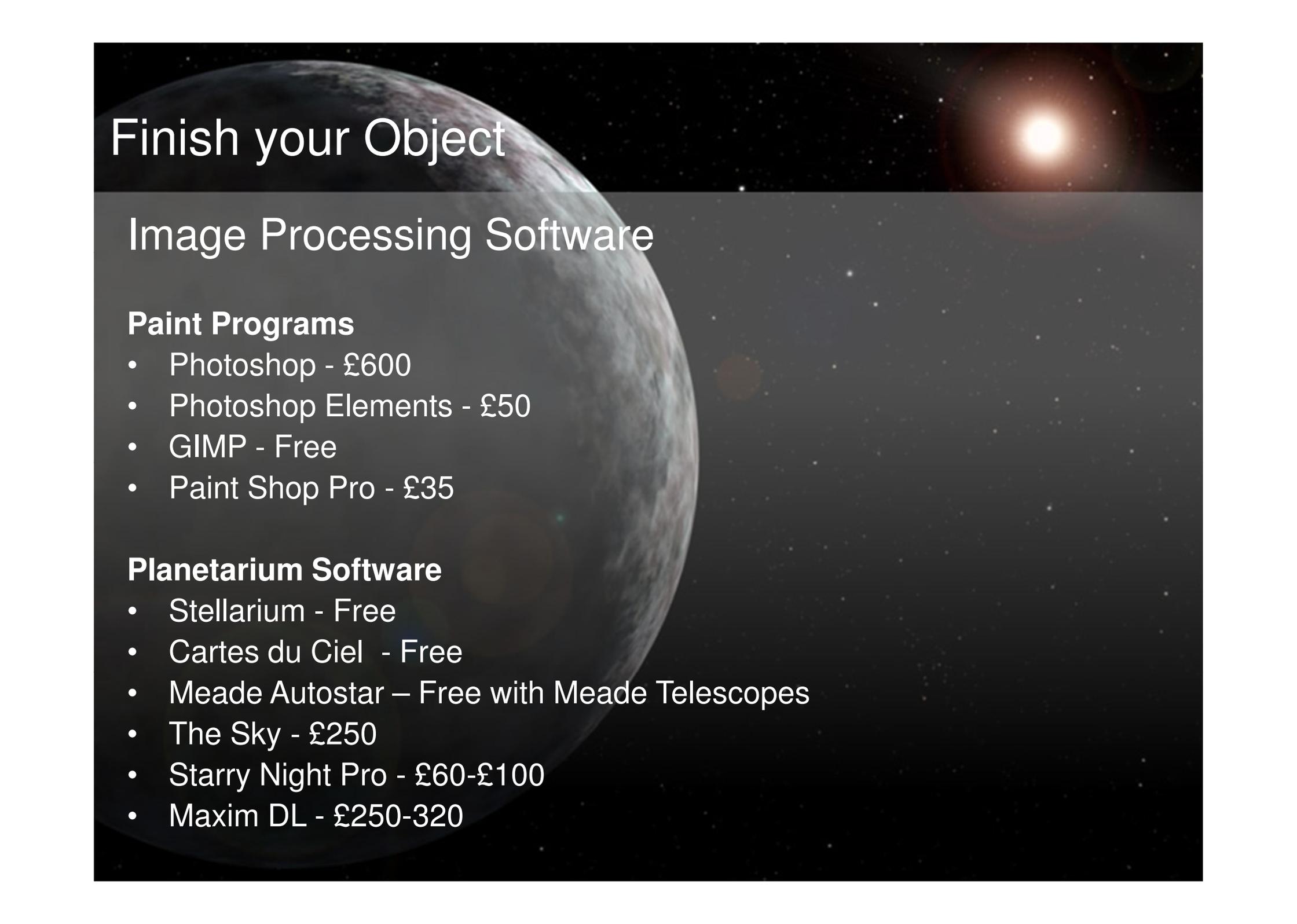
Image Processing Software

Image Capture

- Camera manufacturers own software - Free
- Maxim DL – £250-£320
- AstroArt - £110
- Nebulosity - £50

Image Processing

- Deep Sky Stacker – Free
- iRis – Free
- FITS Liberator - Free
- Maxim DL – £250-£320
- AstroArt - £110
- Nebulosity - £50
- CCDStack - £120
- PixInsight - £150



Finish your Object

Image Processing Software

Paint Programs

- Photoshop - £600
- Photoshop Elements - £50
- GIMP - Free
- Paint Shop Pro - £35

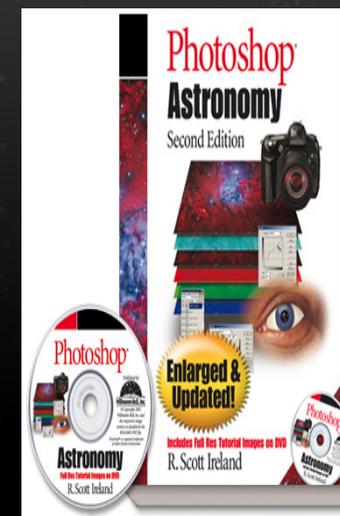
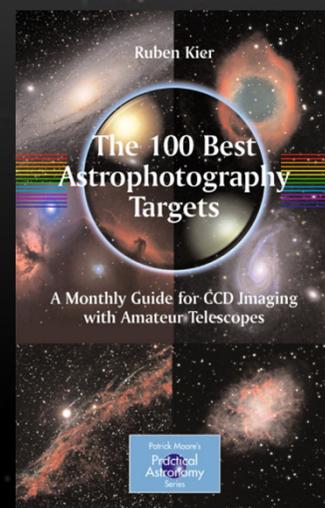
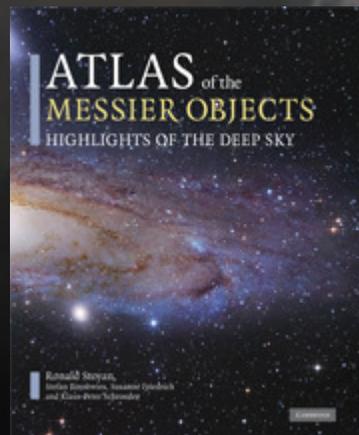
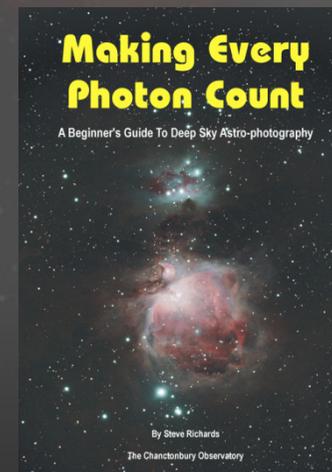
Planetarium Software

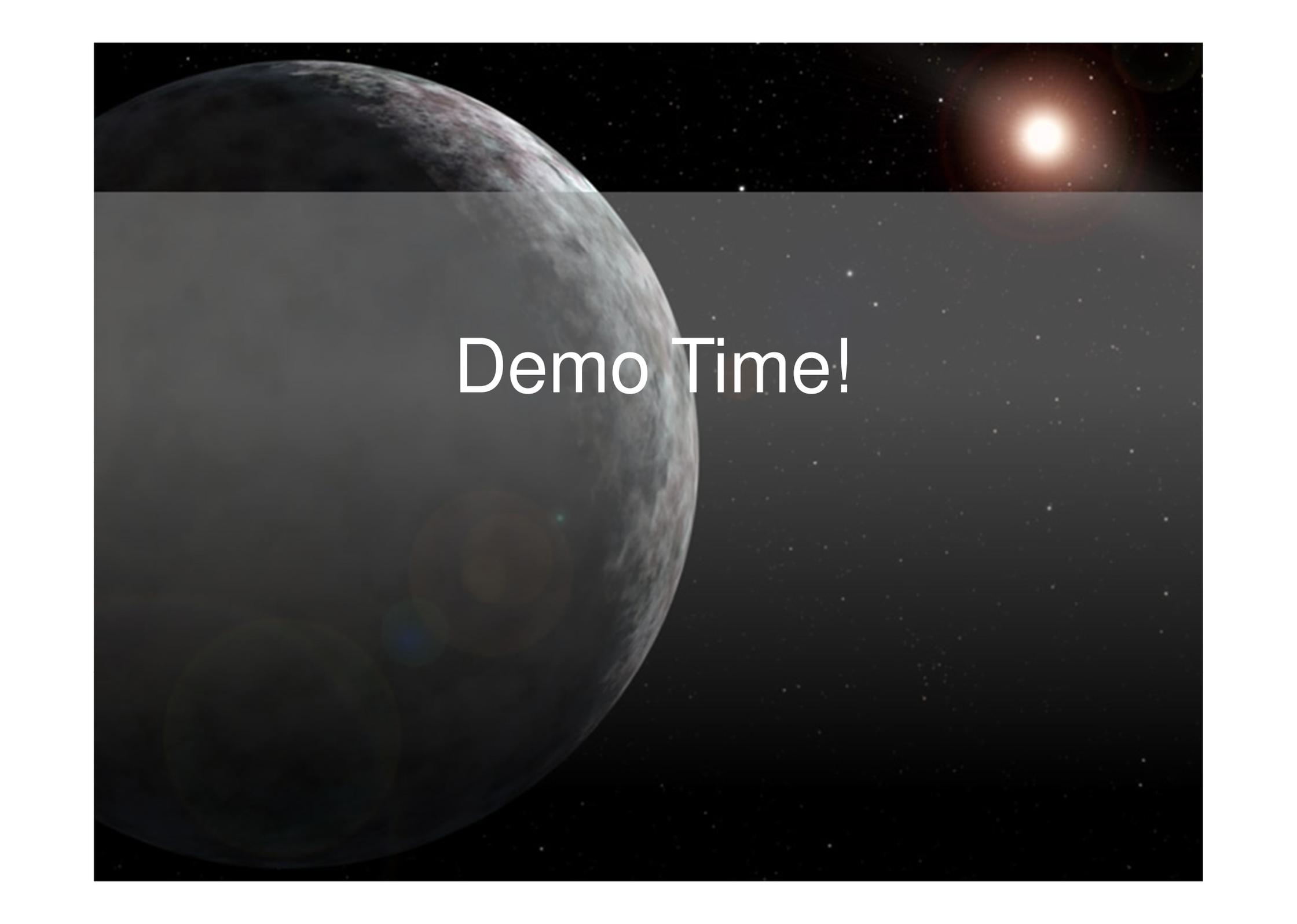
- Stellarium - Free
- Cartes du Ciel - Free
- Meade Autostar – Free with Meade Telescopes
- The Sky - £250
- Starry Night Pro - £60-£100
- Maxim DL - £250-320

Further Reading

- Making Every Photon Count by Steve Richards
- Photoshop Astronomy by Scott Ireland
- The 100 Best Astrophotography Targets by Ruben Kier
- Atlas of the Messier Objects from Cambridge Univ. Press
- Digital SLR Astrophotography by Michael A Covington

Check the CAA library!



A space-themed background featuring a large, detailed moon on the left side, a bright sun in the upper right corner, and a field of stars against a dark sky. A semi-transparent grey horizontal bar is positioned across the middle of the image.

Demo Time!



The End

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