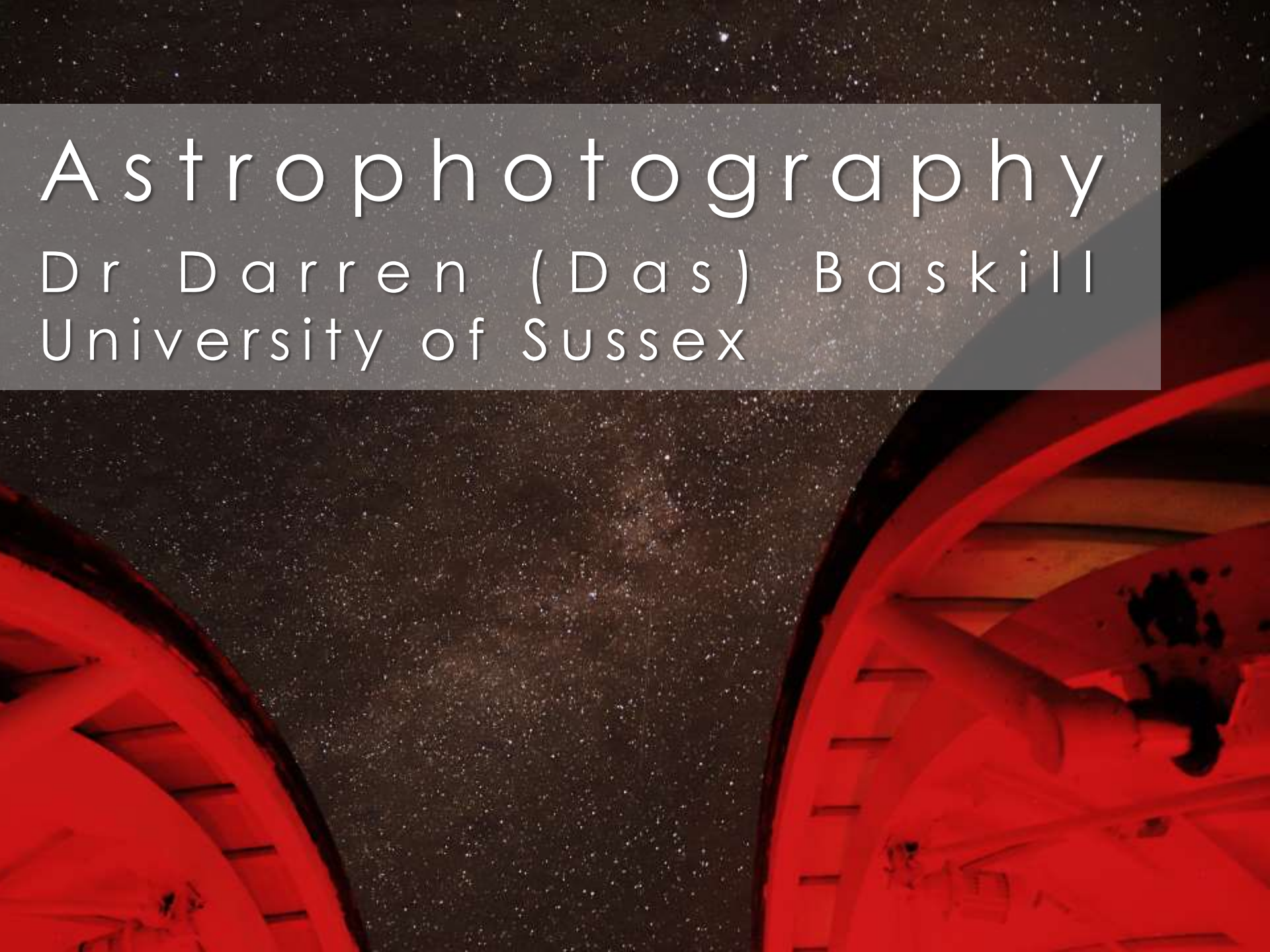


Astrophotography

Dr Darren (Das) Baskill
University of Sussex

Welcome & Introduction

Lecturer in Physics & Astronomy at the University of Sussex, also running our outreach programme.

Previous jobs include:

- Educator at the Royal Observatory Greenwich
- XMM-Newton calibration scientist
- PhD in X-ray astronomy (CV stars)


Observing in Hawai'i...

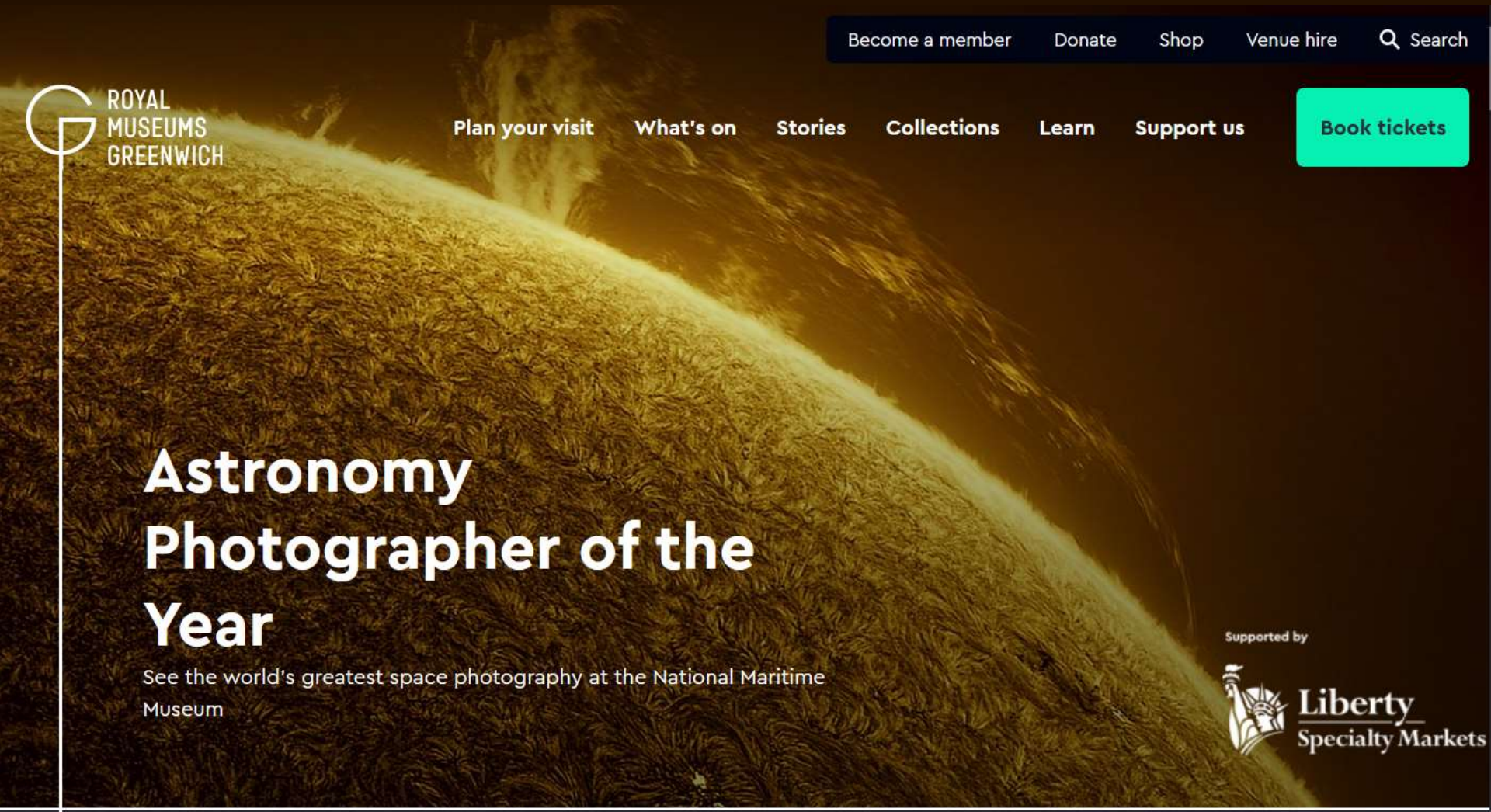
Doing outreach in schools & elsewhere

Media work


BBC NEWS
Northern Lights expected again across UK later
• US report criticises Israel's use of American-supplied weapons in Gaza
15:37


THE CONVERSATION
Why do the aurora look better through a camera? And how do you spot a fake image? Q&A with an astrophotographer
On 10 and 11 May 2024, large parts of the world were treated to their most spectacular display of the aurora – the northern and southern lights – in a generation. Thanks to modern cameras, the phenomenon

Initiated APotY in 2007




Astrophotography
The Sun & Moon (& settings)
Wide angle night sky
Processing &
Deep sky targets
with a telephoto lens
Time-lapse photography

Imaging the Sun & Moon

The Sun

The Sun

The Sun

Next partial solar eclipse

10am-noon, Saturday 29th March

The Sun

Pin hole projection with…

Coffee cups

Scarfs

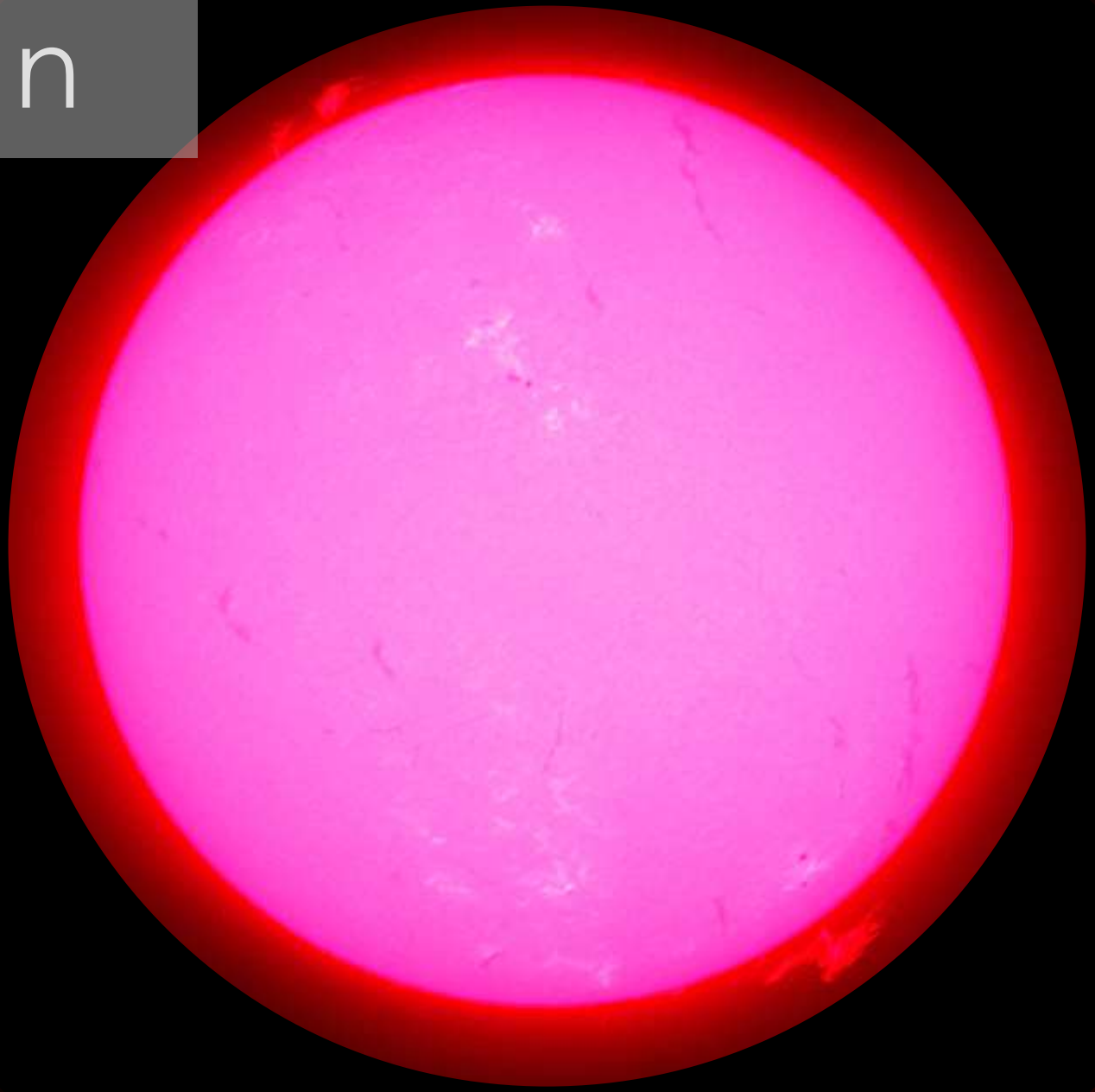
Colander

Card + holes

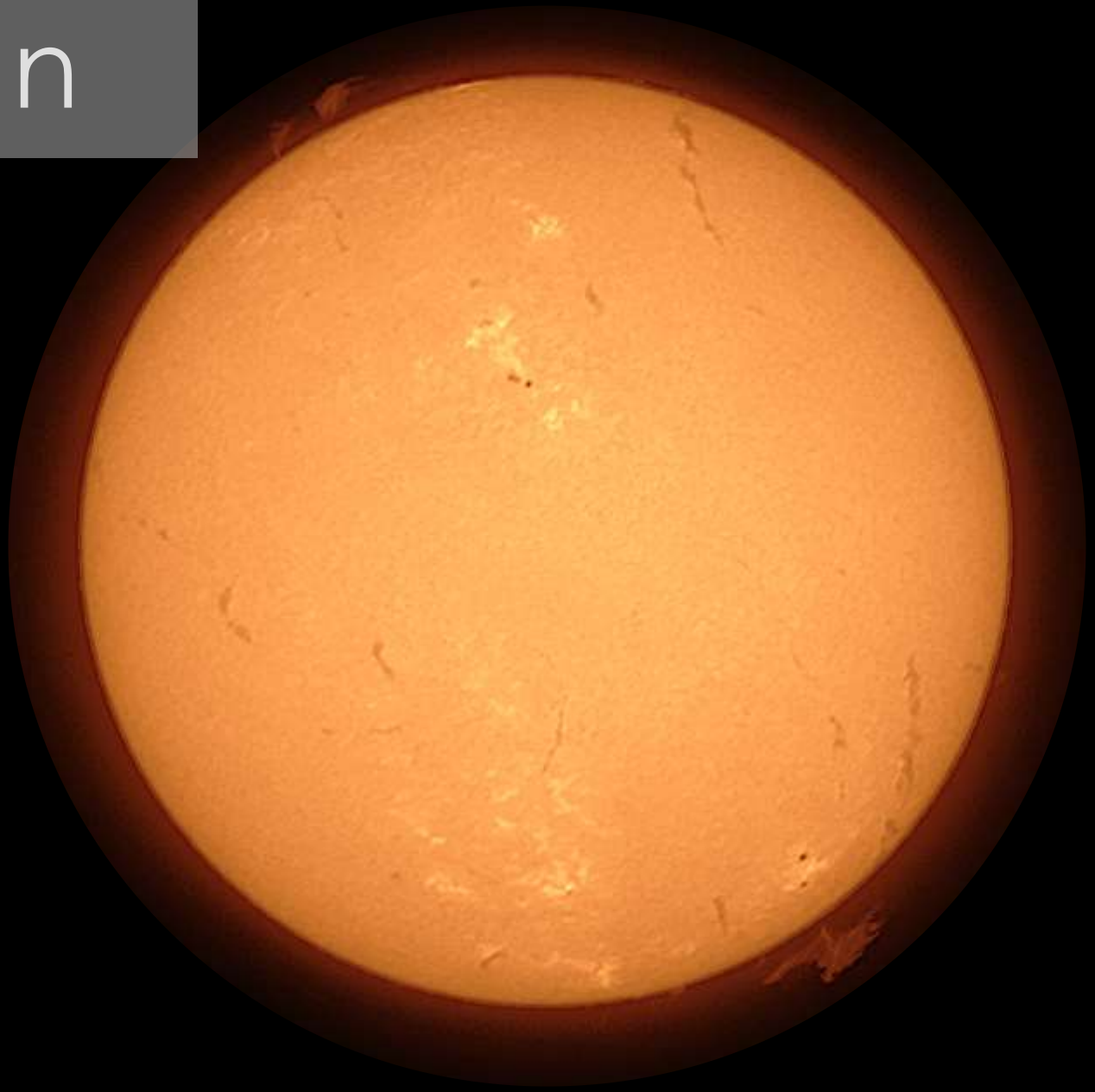
Anything!

The Sun

The Sun



The Sun



The Sun & Moon

Method

- Autofocus
- Autoexposure
- Auto f/number

The Moon

The Moon


The Moon


The Moon
Planned using Stellarium
and an OS map


The Moon
Planned using Stellarium
and an OS map

Method: Camera settings

- f/number
- Exposure time
- ISO setting

Method: Camera settings

- f/number
- Exposure time
- ISO setting

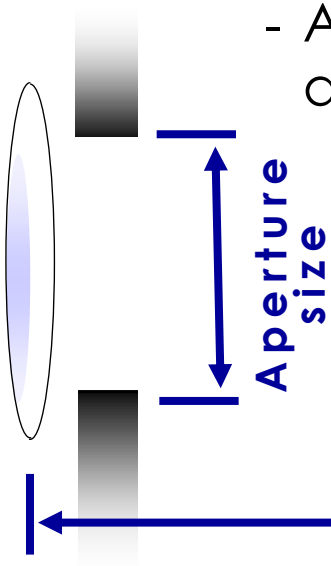
Decrease to collect more light...

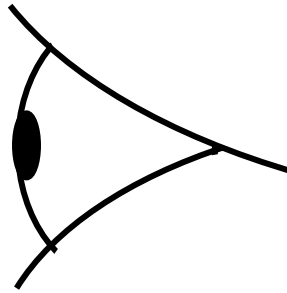
... Or increase to get a greater depth of field.

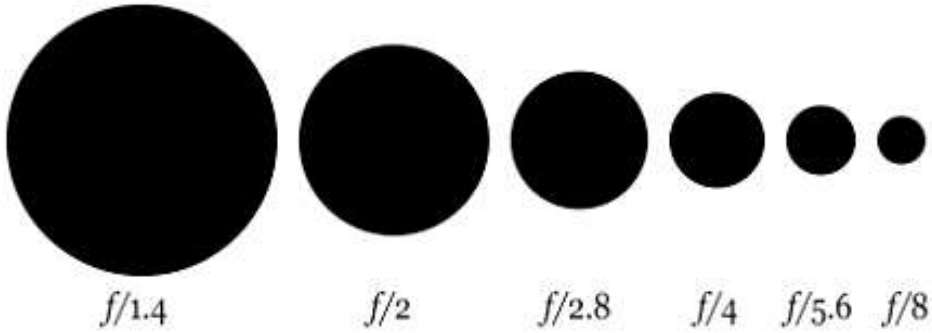
f-number

f/number is the aperture size (opening) of a lens, in terms of Focal length

- f/2 means that the aperture (opening) is one half the focal length of the lens
  - Affects the amount of light entering a lens and the focal depth…








f/4.5


f/6.7


f/9.5


f/13


f/32


f/5


f/32

The Moon

By Laurent Laveder

http://www.pixheaven.net


The Moon
By Laurent Laveder
http://www.pixheaven.net


The Moon
By Laurent Laveder
http://www.pixheaven.net


f/5.6
f/11
The Moon

The Moon


The Moon
f/20


The Moon
f/20


The Moon


The Moon


The Moon


The Moon


The Moon

The Moon

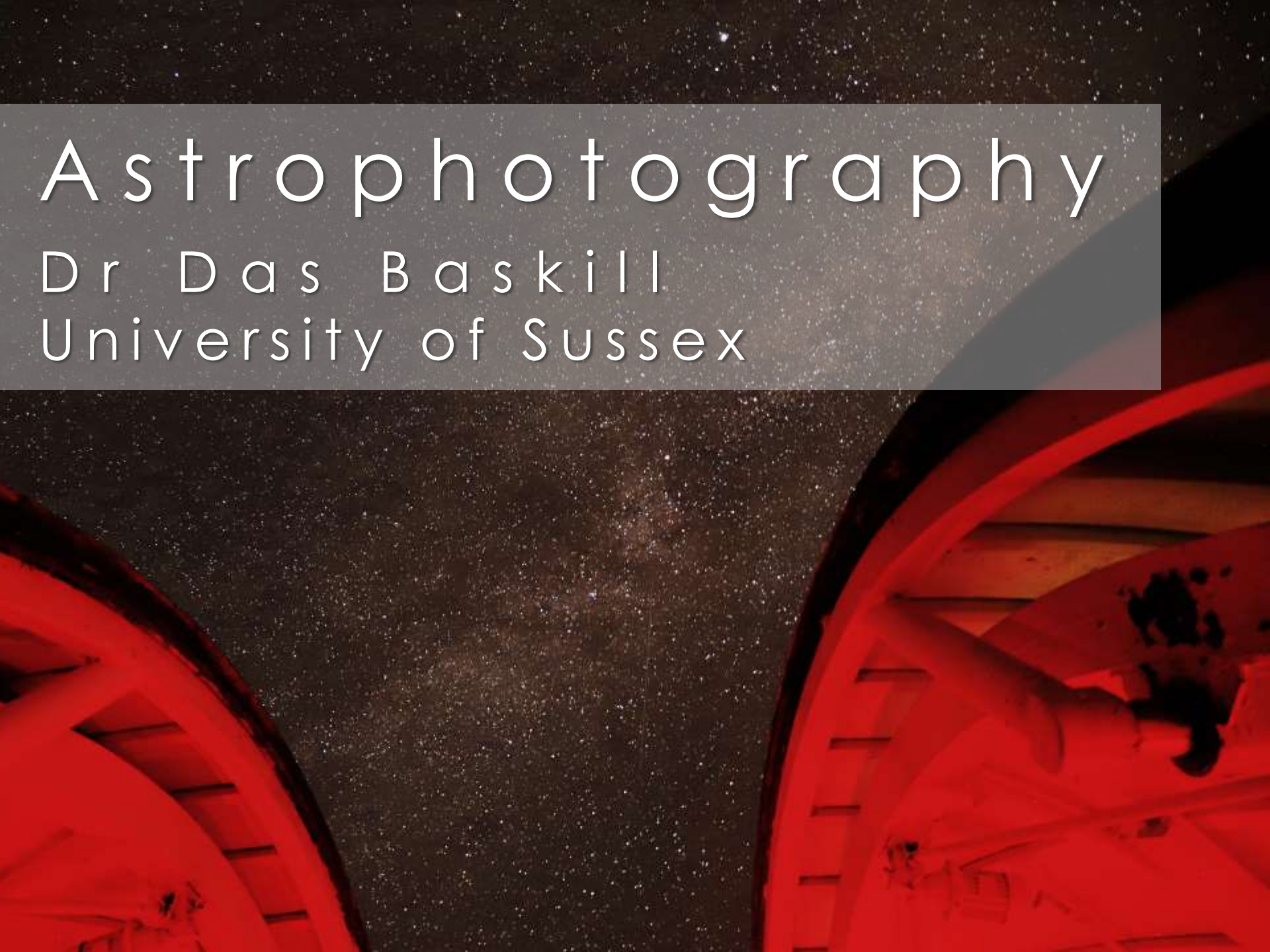
over London,
Vienna & Madrid

Camera adapters


The Moon

The Sun & Moon Summary

- Always search for interesting **foreground** objects
- Focal depth?
  Diffraction spikes?



Astrophotography

Dr Das Baskill
University of Sussex


Wide angle imaging
of the night sky

The DSLR

Sensitive at low light levels

Method: Camera settings

- f/number
- Exposure time
- ISO setting

Method: Camera settings

- f/number
- **Exposure time**
- ISO setting

Increase to collect more light...

...But objects move across the sky & light pollution.

Exposure Time

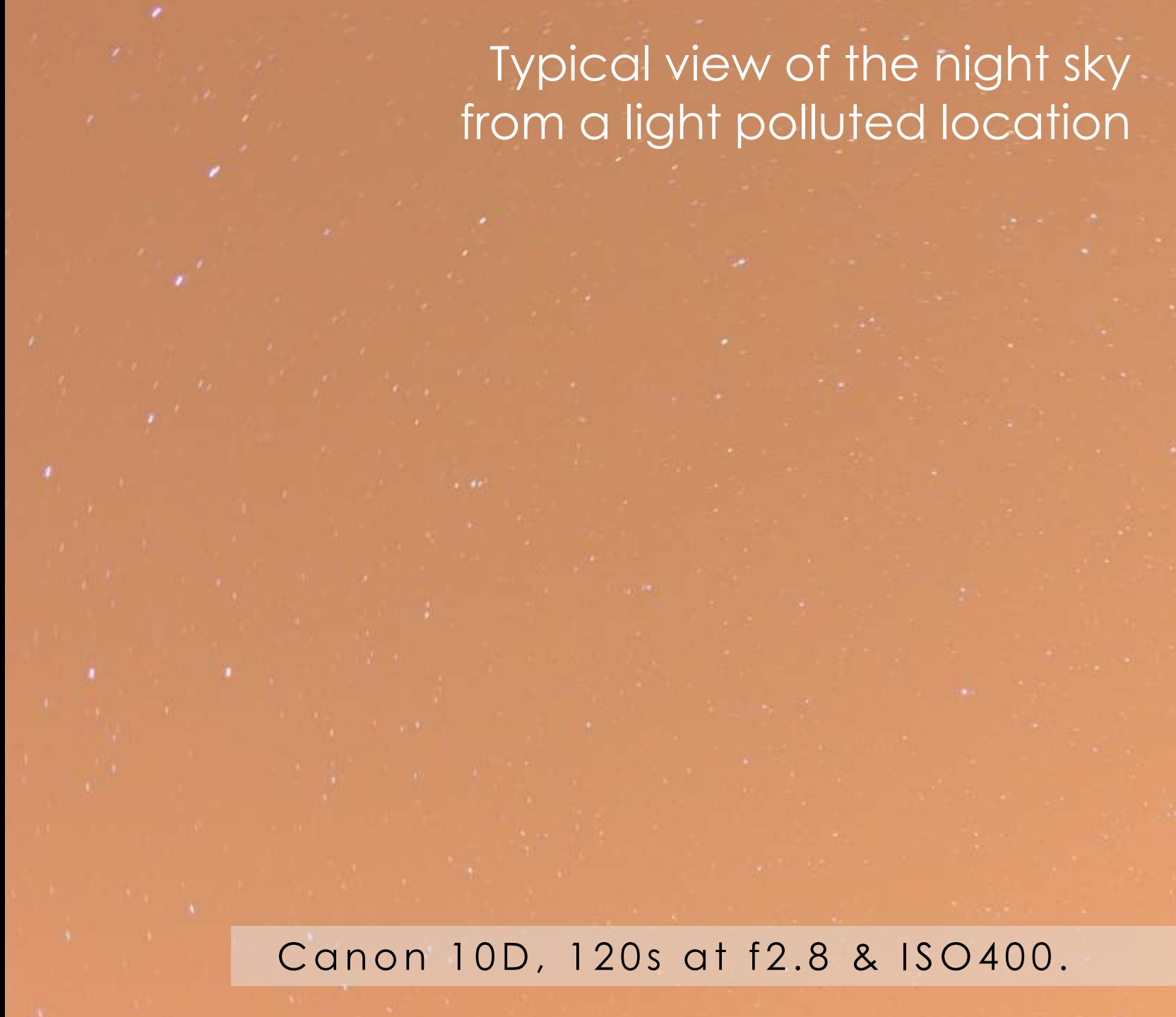
Short: $^{1}/_{8}$ seconds

Exposure Time

Longer: 2s


Exposure time: 10 hours!

Light pollution



Typical view of the night sky from a light polluted location

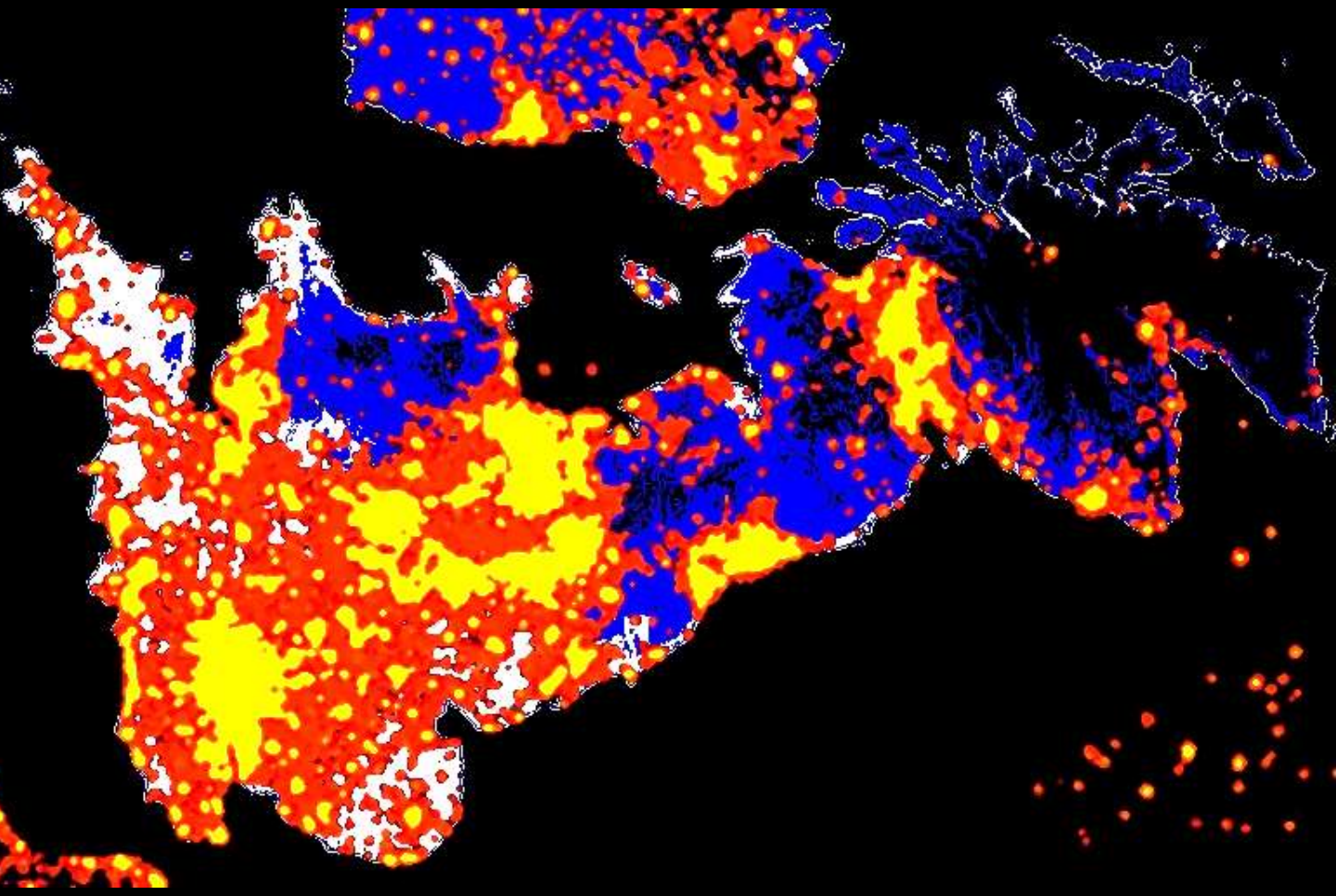
Canon 10D, 120s at f2.8 & ISO400.

Light pollution

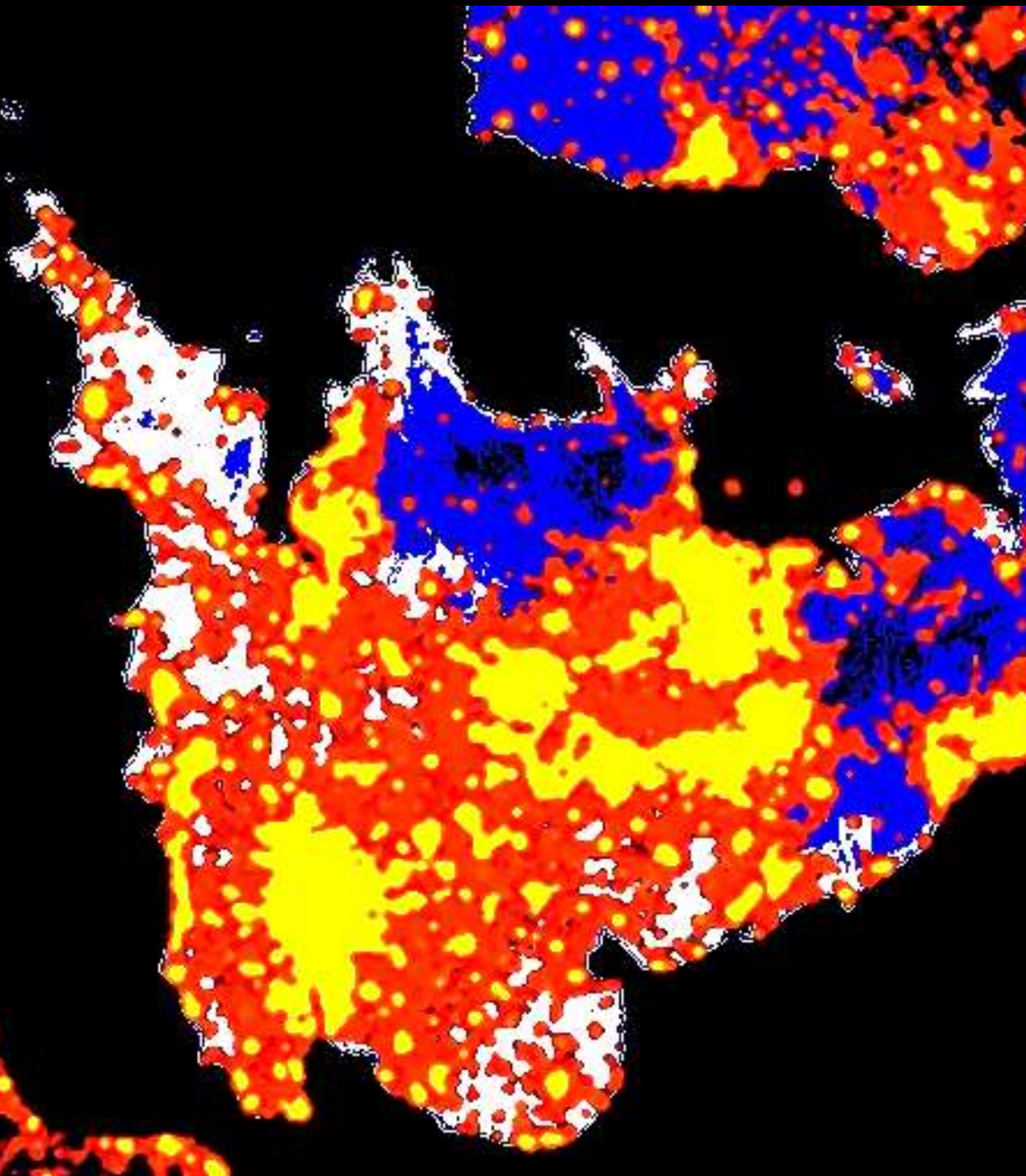

Light pollution from the inefficient lights of Brighton

Light pollution

Light pollution



Light pollution



Method: Camera settings

- f/number
- Exposure time
- ISO setting

[1/3] ISO is a standard measure of how a digital camera amplifies a signal (image) after a photograph is taken.

Method: Camera settings

- f/number
- Exposure time
- ISO setting

[2/3] Increasing the ISO amplifies the signal (and so brightness)...
...but also amplifies the imperfections/noise too.

Method: Camera settings

- f/number
- Exposure time
- ISO setting

[3/3] These imperfections can be reduced by taking and removing a **dark frame**

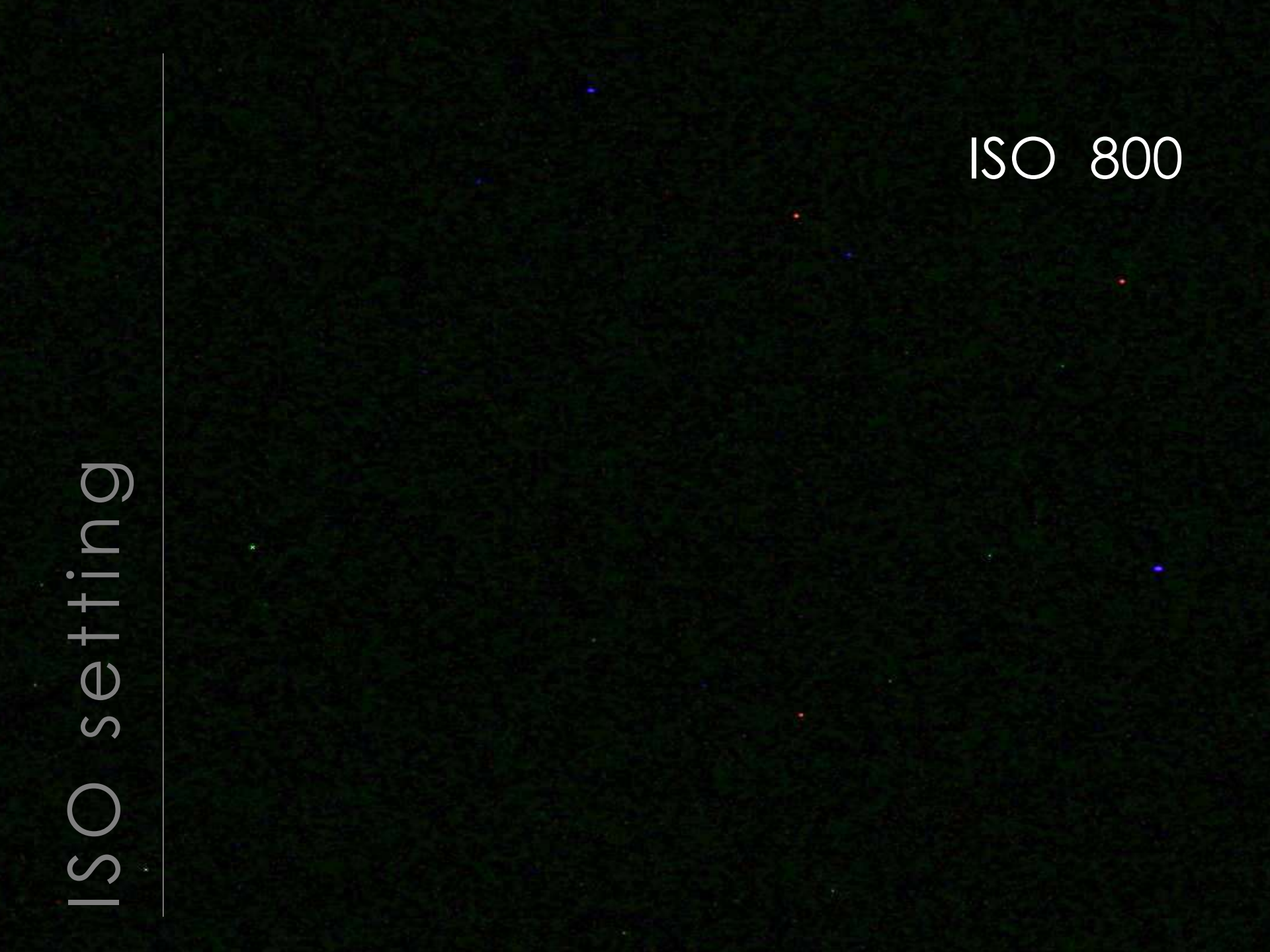
ISO setting

ISO 100

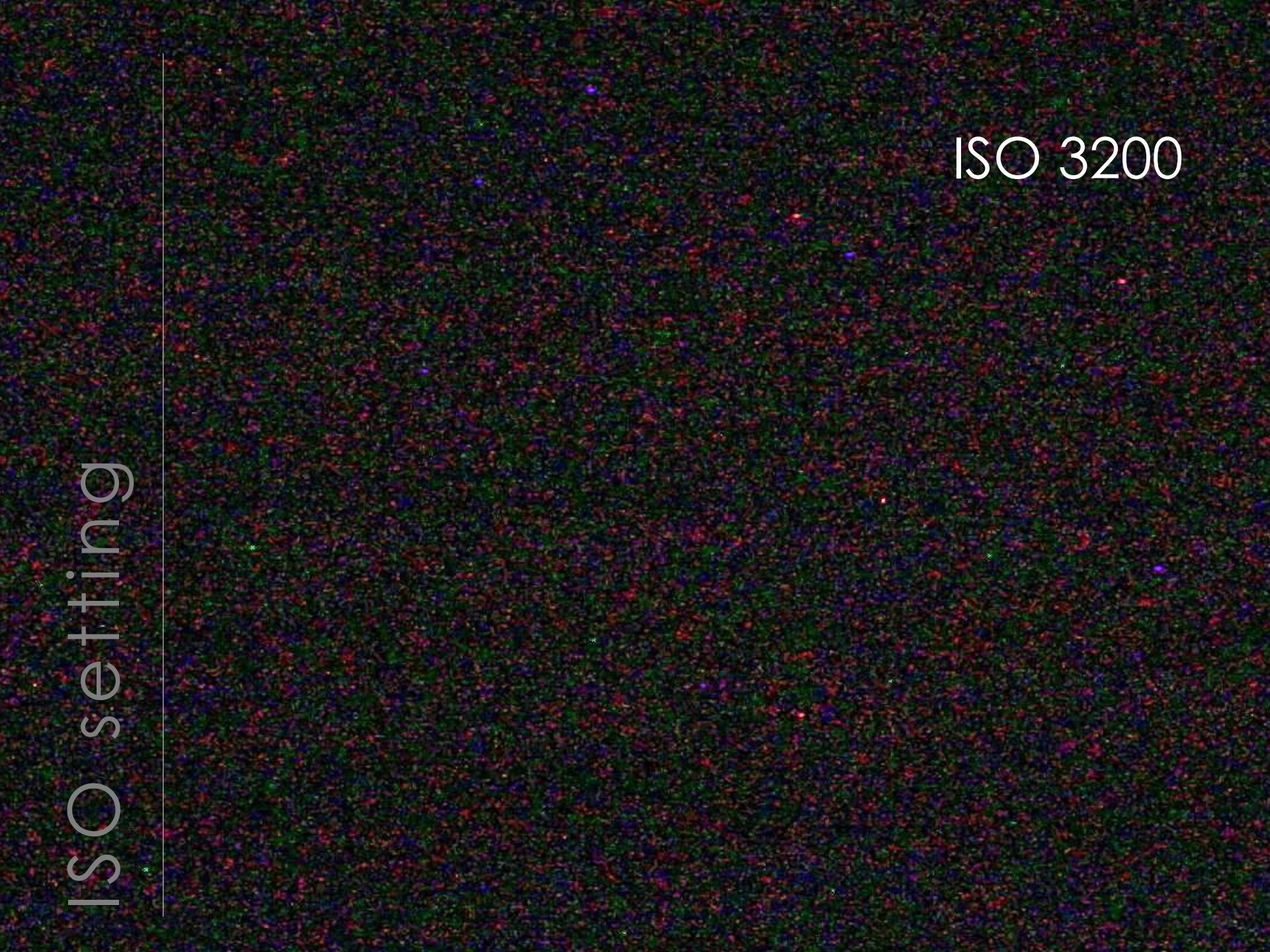
ISO setting

ISO 200

ISO setting


ISO setting
ISO 800


ISO setting
ISO 1600


ISO 3200
ISO setting

Method: Camera settings

- f/number
- Exposure time
- ISO setting

The Moon

Exposure: Auto

ISO: Auto

Aperture: Auto

The Moon

Exposure: 3s

ISO: 3200

Aperture: f/7

Camera settings *for shooting the Moon*

- f/number — Anything from f/4.0 to f/32 !
- Exposure time — Short exposures for the bright Moon: 1/50s-1/200 s
- ISO setting — The Moon is bright so ISO~200. unless you want diffraction spikes, then ISO1600+.

The Milky-way

Best seen in August & September


Milky way
< Andromeda galaxy


< Milky way
< Andromeda galaxy

International views

Travel for darker skies and different views


Utah, USA


Hawai’i
Brighton’s horizon


Southern Hemisphere

Meteors

Shooting stars are very difficult to photograph!

- They're very quick
- Often faint
- And can appear anywhere in the sky


Comet F3 (NEOWISE)
July 2020
30 seconds
f/5.6
ISO 3200


Meteors

Camera settings *for shooting stars*

- Exposure time — 10 - 30 seconds until light pollution dominates…
- ISO setting — Camera needs maximum sensitivity: ISO 3200+
- f/number — Wide open aperture e.g. f/2.8 to allow as much light in as possible

And take large numbers of photos!

Meteors

Best showers are in August & December

Spot the difference!

Aircraft/drones

- Flash!
- Take minutes to pass overhead.
- May change direction.

Satellites

- Usually constant brightness, but...
- May glint sunlight
- Or vary if tumbling space debris
- Take minutes to pass

Meteors

- Burn up in a second!
- Have uneven tracks as they explode.
- Shooting stars are often colourful.

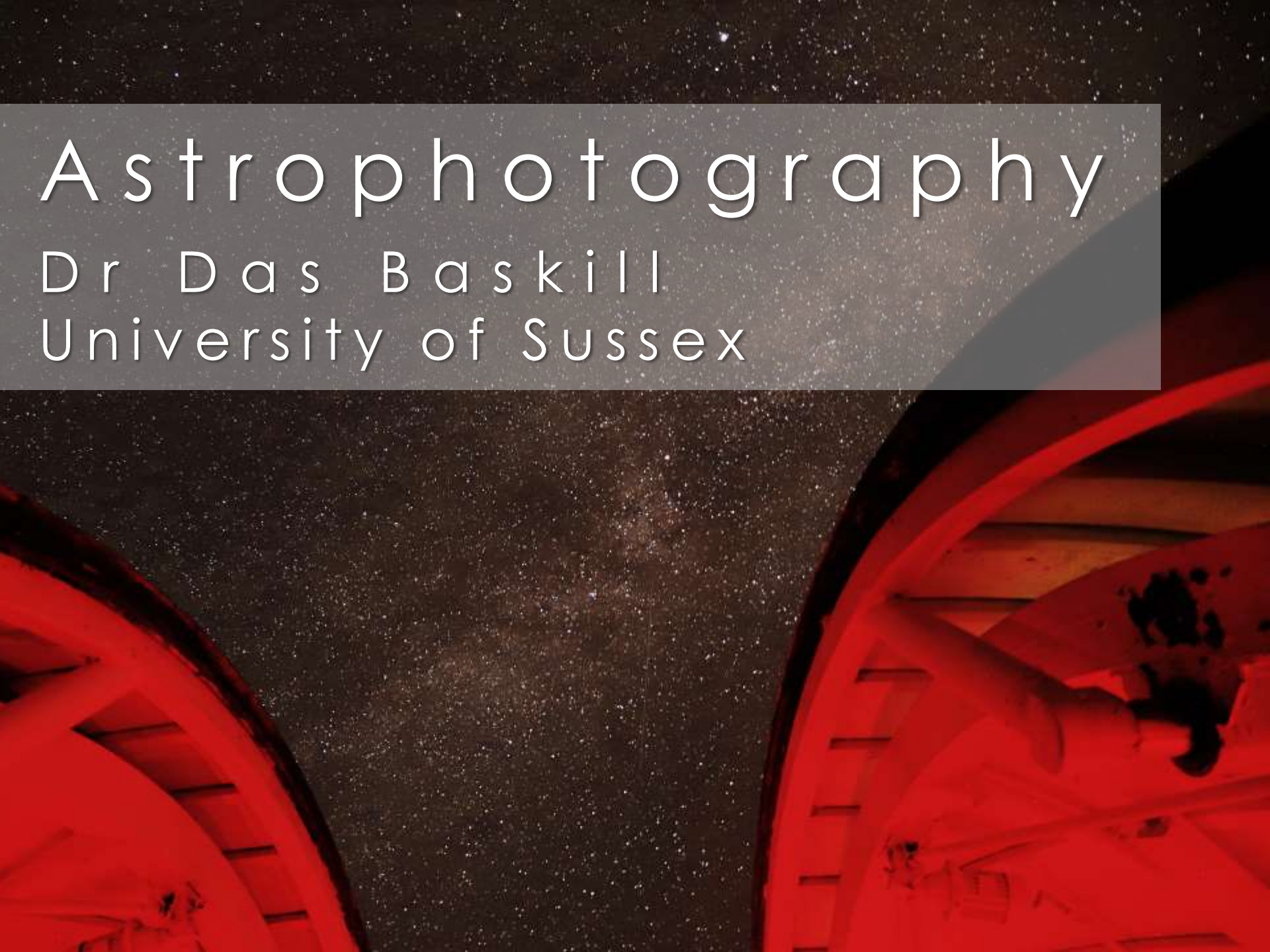

Aurora
May 2024


Aurora
May 2024


Aurora
October
2024

Wide angle summary

- Settings
- Location
- Time of the year



Astrophotography

Dr Das Baskill
University of Sussex

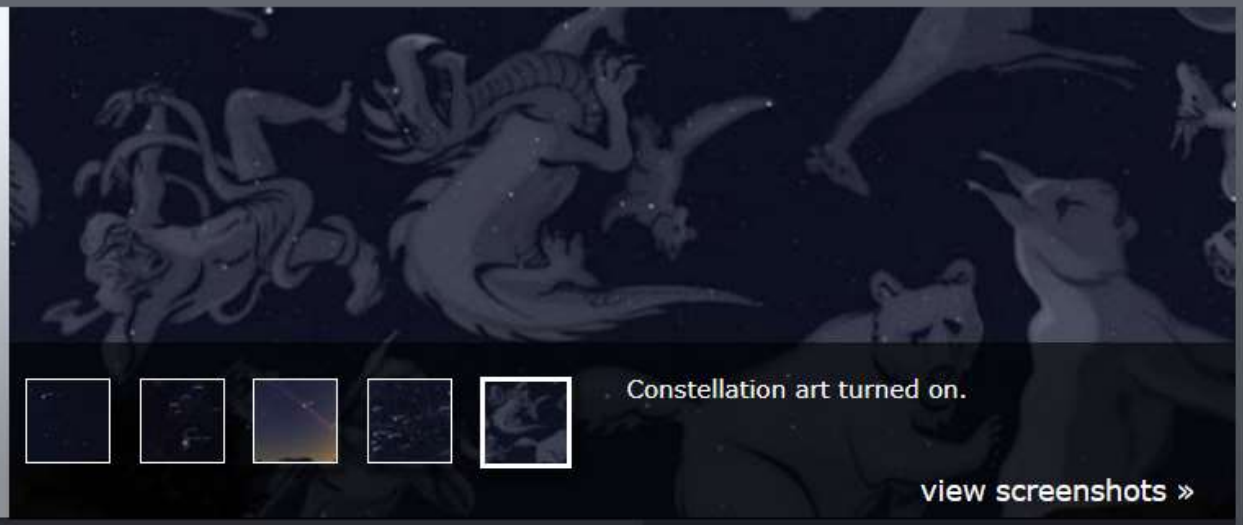

Processing,
tracking
&Deep sky imaging

stellarium

latest version is 24.4

Linux source | Linux snap | Linux amd64; Qt5; AppImage | macOS 11.0+; Qt6; universal | Windows x86_32; Qt5; Windows 7+ | Windows x86_64; Qt5; Windows 7+ | Windows x86_64; Qt6; Windows 10+ | Stellarium Web

Stellarium is a free open source planetarium for your computer. It shows a realistic sky in 3D, just like what you see with the naked eye, binoculars or a telescope.



Constellation art turned on.

view screenshots »

features

sky

- default catalogue of over 600,000 stars
- extra catalogues with more than 177 million stars
- default catalogue of over 80,000 deep-sky objects
- extra catalogue with more than 1 million deep-sky objects
- asterisms and illustrations of the constellations

news

- Stellarium 24.4
- Stellarium 24.3
- Stellarium 24.2
- Stellarium 24.1
- Stellarium 23.4
- Stellarium 23.3
- Stellarium 23.2
- Stellarium 23.1
- Stellarium 1.2
- Stellarium 1.1

collaborate

You can learn more about Stellarium, get support and help the project from these links:

- discussions
- mailing list
- wiki
- FAQ
- scripts
- landscapes

Astrophotography

Processing

I use:

- Sequator
  - for stacking an aligning images
- GIMP
  - to improve the final image (brightness, contrast, etc)

Both are free windows software.

GNU Image Manipulation Program

File Edit Select View Image Layer Colors Tools Filters Windows Help

Custom
FG to BG (Hardedge)
FG to BG (HSV clockwise hue)
FG to BG (HSV counter-clockwise)
FG to BG (RGB)
FG to Transparent
FG to Transparent (Hardedge)
Abstract 1
Abstract 2
Abstract 3
Aneurism
Blinds
Blue Green
Browns
Brushed Aluminium
Burning Paper
Burning Transparency
Caribbean Blues
CD
CD Half
Coffee
Cold Steel
Cold Steel 2
Crown molding
Dark 1
Deep Sea
Default
Flare Glow Angular 1
Flare Glow Radial 1

enter tags

About GIMP

GIMP 2.10.36

GNU Image Manipulation Program

Copyright © 1995-2023
Spencer Kimball, Peter Mattis and the GIMP Development Team

Update available!

Download GIMP 2.10.38 revision 1 (released on 10/03/24)

Release comment: *GTK+ patches updated.*
Last checked on 03/05/25 at 20:52:49

Visit the GIMP website

Credits License Close

Processing steps

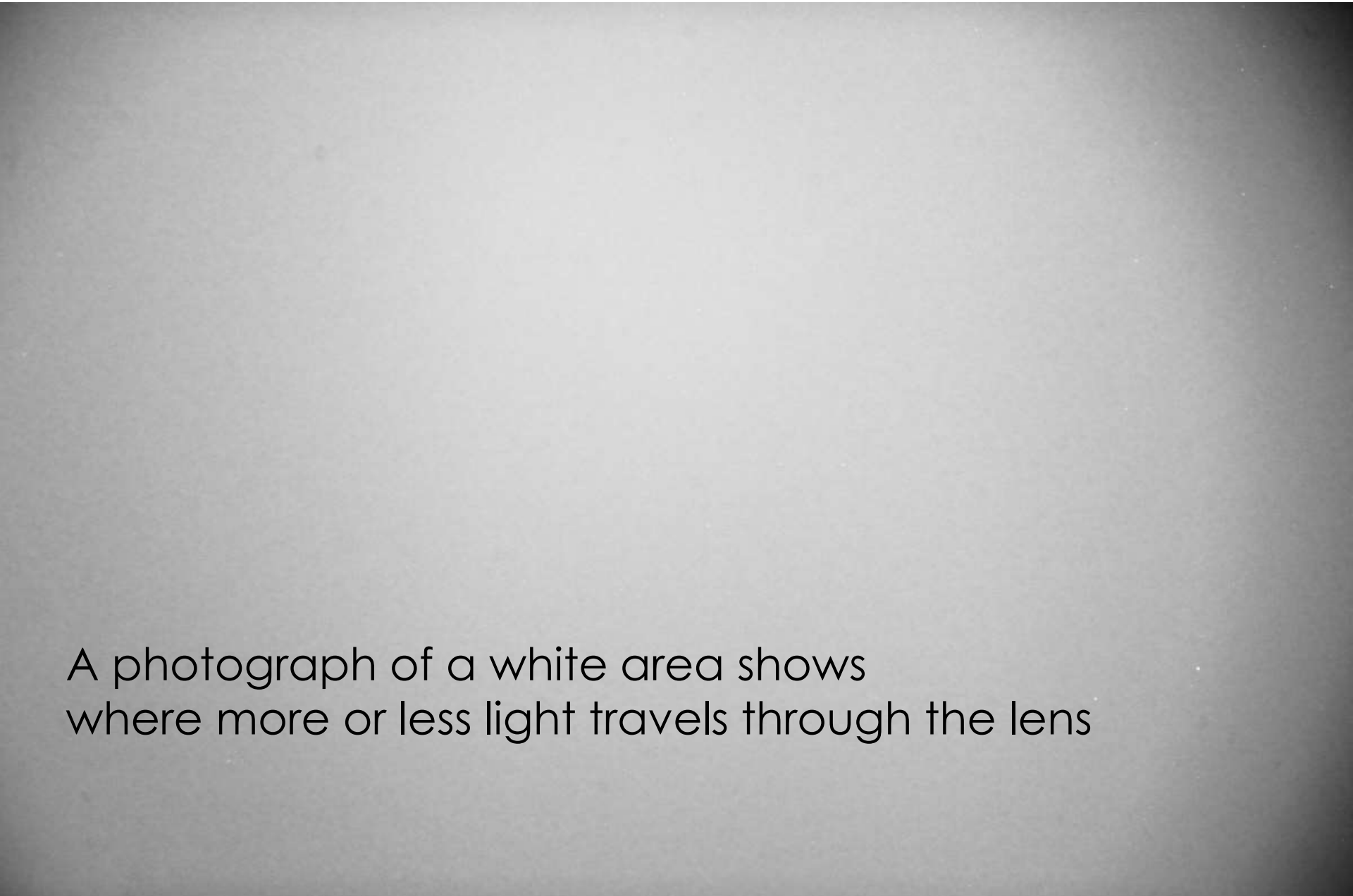
1. Take multiple images
2. Calibration
    - Take & subtract a dark frame


ISO 3200
Dark Frame

Processing steps

1. Take multiple images
2. Calibration
    - Take & subtract a dark frame
    - Take & divide by a flat field

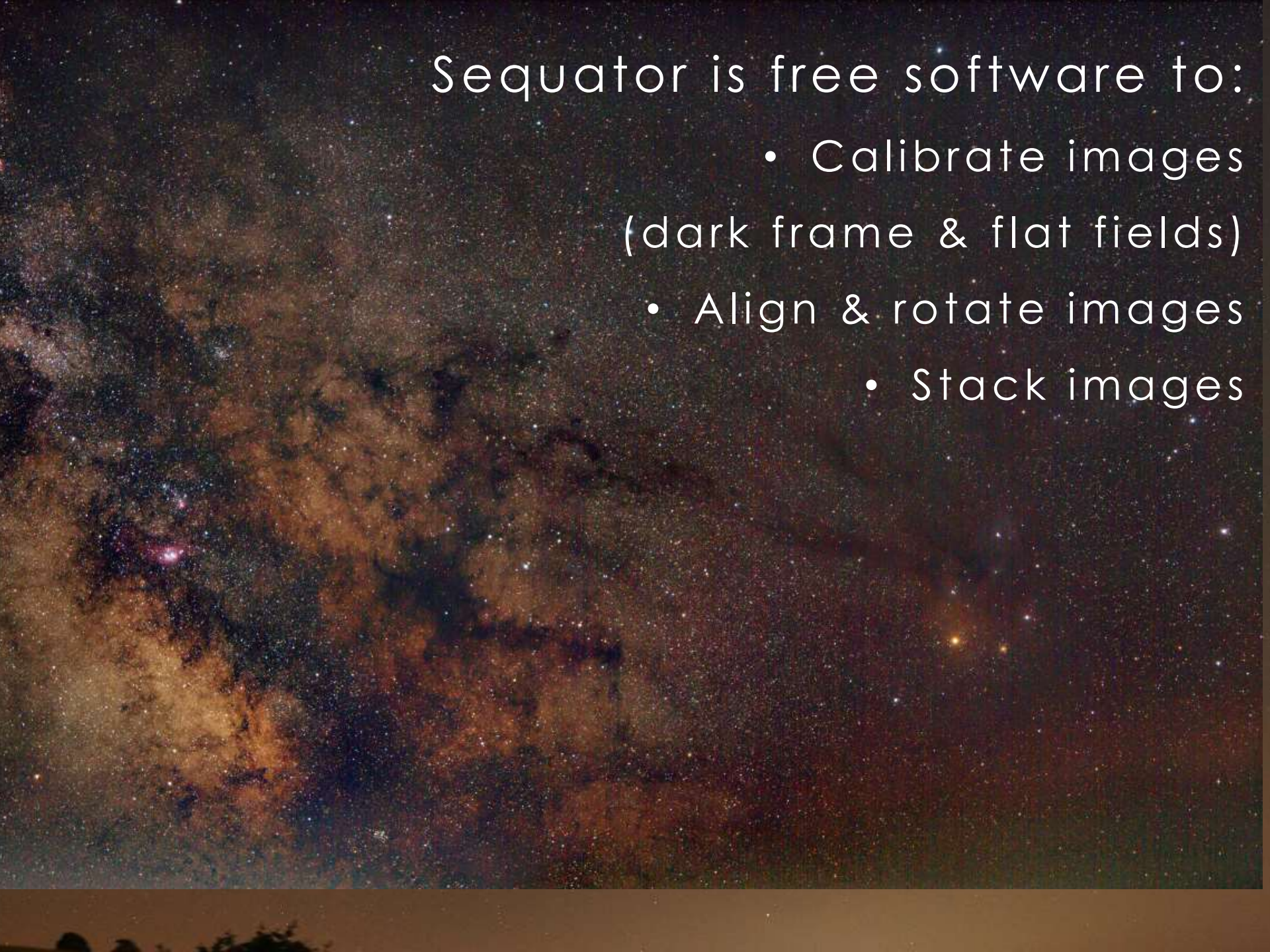
Flat field image



A photograph of a white area shows
where more or less light travels through the lens

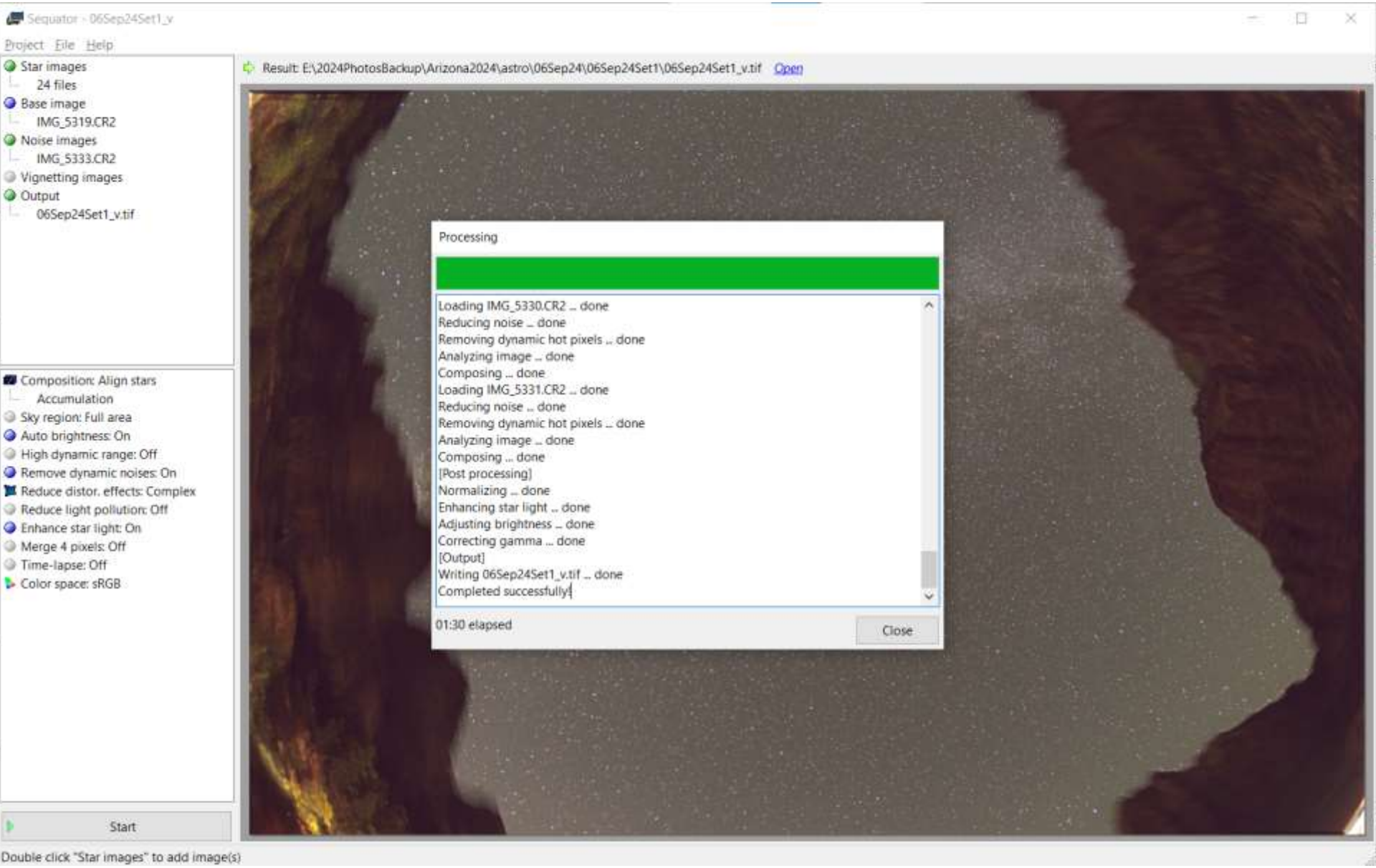
Processing steps

1. Take multiple images
2. Calibration
    - Take & subtract a dark frame
    - Take & divide by a flat field
3. Step 2: Align & stack your images
4. Step 3: Additional processing (brightness, contrast, colours, light pollution reduction, etc...)



Sequator is free software to:

- Calibrate images (dark frame & flat fields)
- Align & rotate images
- Stack images


Sequator - 06Sep24Set1_v
Project File Help
Star images
24 files
Base image
IMG_5319.CR2
Noise images
IMG_5333.CR2
Vignetting images
Output
06Sep24Set1_v.tif
Result: E:\2024PhotosBackup\Arizona2024\astro\06Sep24\06Sep24Set1\06Sep24Set1_v.tif Open
Composition: Align stars
Accumulation
Sky region: Full area
Auto brightness: On
High dynamic range: Off
Remove dynamic noises: On
Reduce distor. effects: Complex
Reduce light pollution: Off
Enhance star light: On
Merge 4 pixels: Off
Time-lapse: Off
Color space: sRGB
Start
Double click "Star images" to add image(s)
Processing
Loading IMG_5330.CR2 ... done
Reducing noise ... done
Removing dynamic hot pixels ... done
Analyzing image ... done
Composing ... done
Loading IMG_5331.CR2 ... done
Reducing noise ... done
Removing dynamic hot pixels ... done
Analyzing image ... done
Composing ... done
[Post processing]
Normalizing ... done
Enhancing star light ... done
Adjusting brightness ... done
Correcting gamma ... done
[Output]
Writing 06Sep24Set1_v.tif ... done
Completed successfully!
01:30 elapsed
Close

Sequator - 06Sep24Set1_v

Project File Help

- Star images
  - 24 files
- Base image
  - IMG_5319.CR2
- Noise images
  - IMG_5333.CR2
- Vignetting images
- Output
  - 06Sep24Set1_v.tif

- Composition: Align stars
  - Accumulation
- Sky region: Full area
- Auto brightness: On
- High dynamic range: Off
- Remove dynamic noises: On
- Reduce distor. effects: Complex
- Reduce light pollution: Off
- Enhance star light: On
- Merge 4 pixels: Off
- Time-lapse: Off
- Color space: sRGB

Start

Result: E:\2024PhotosBackup\Arizona2024\astro\06Sep24\06Sep24Set1\06Sep24Set1_v.tif Open

Double click "Star images" to add image(s)

The Earth rotates…

With a zoom lens, you need an equatorial Mount to follow the stars

30x 30 second photographs, **stacked**

30x 30 second photographs, ***aligned*** **& stacked**

Tracking mounts

Follow the

Stars

Moon

Sun

etc

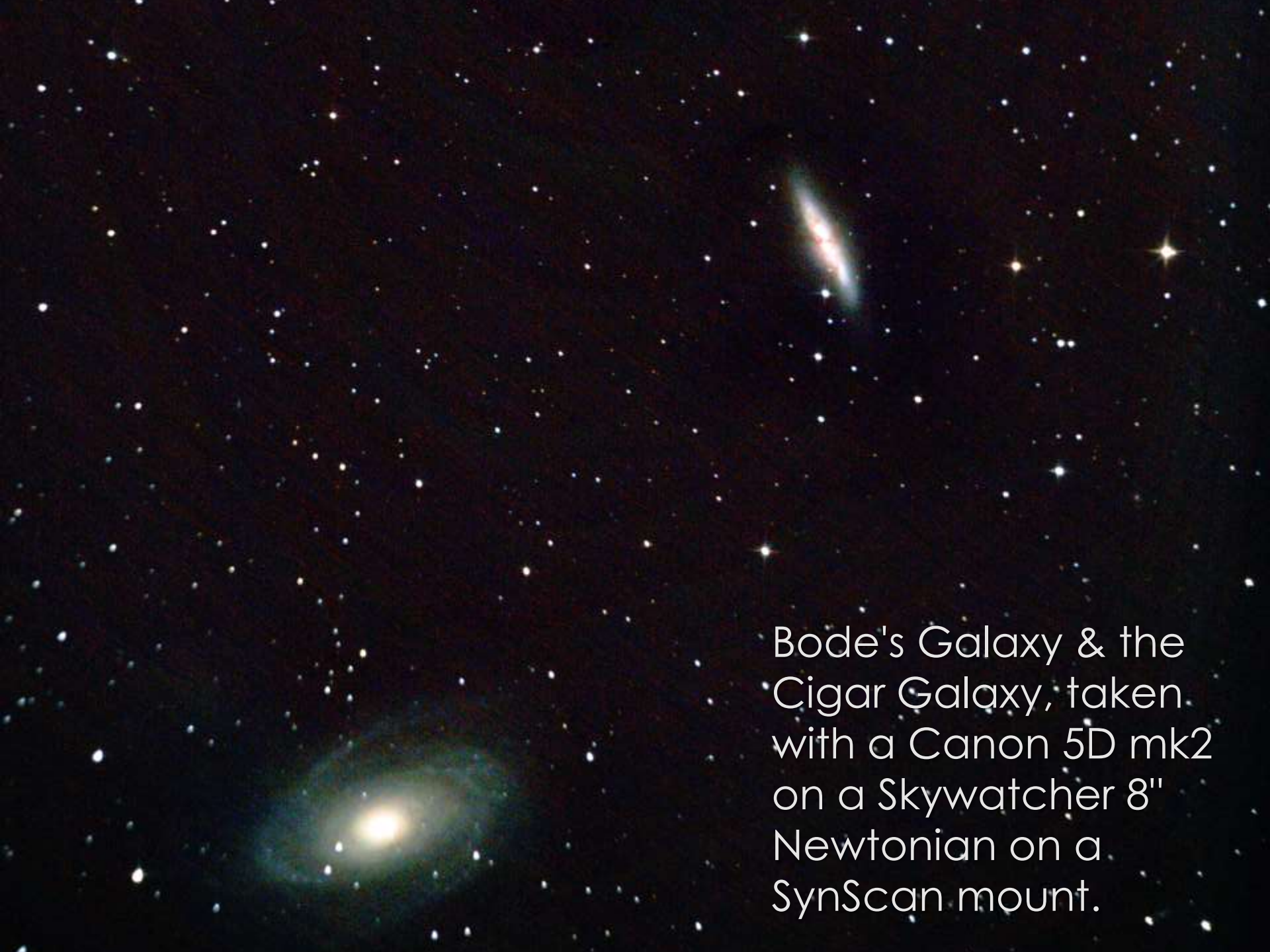
User rj144 on the
Cloudy Nights forum


Roger Hutchinson

Comets

Telescopes

You don't need a telescope for astrophotography, but…



Bode's Galaxy & the Cigar Galaxy, taken with a Canon 5D mk2 on a Skywatcher 8" Newtonian on a SynScan mount.

Exposure time

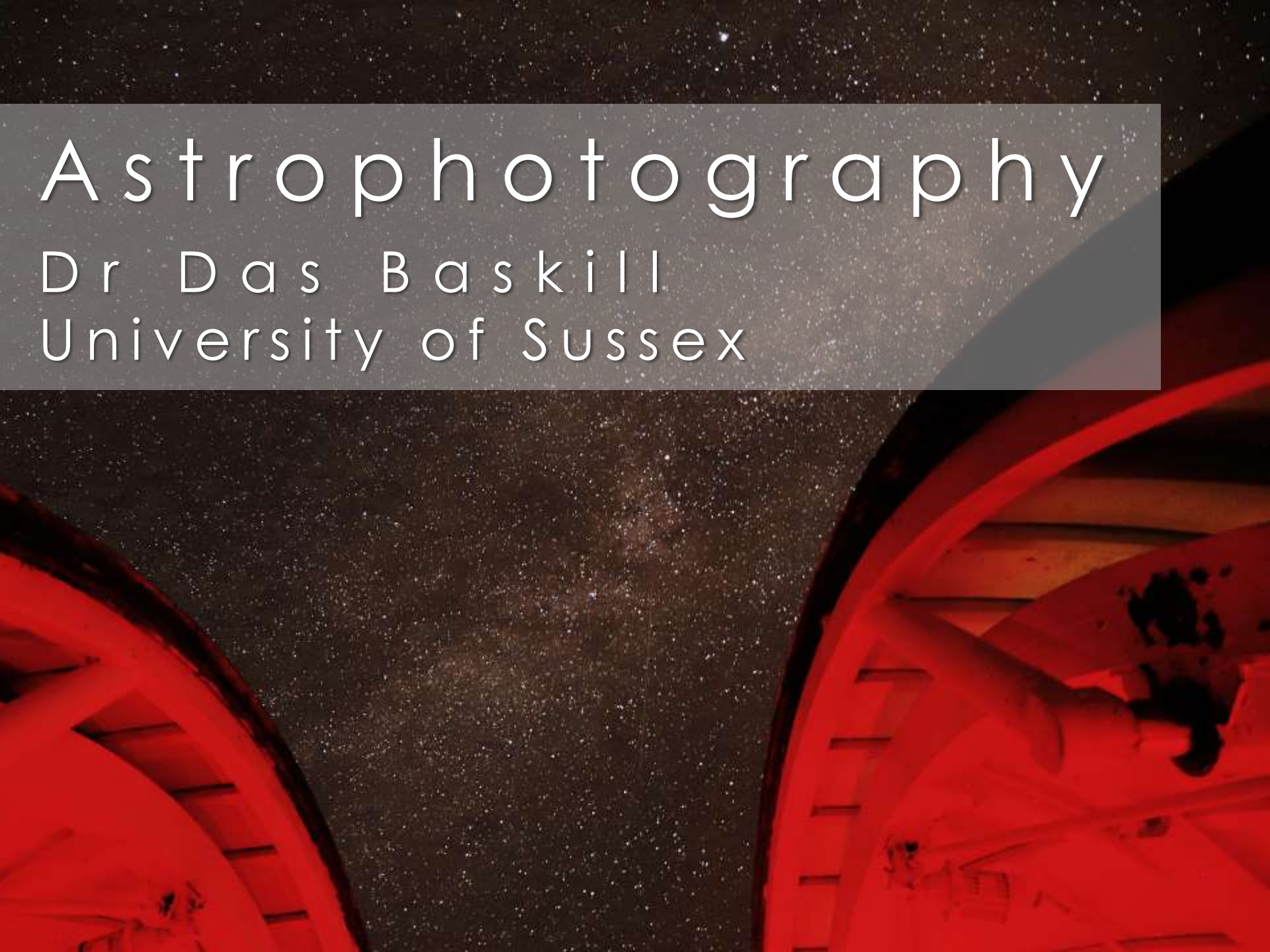
You can increase the exposure time – but accurate tracking is required

Exposure time

You can increase the exposure time – but accurate tracking is required

Processing & Tracking summary

- Brings out more details
- Tracking essential for individual targets

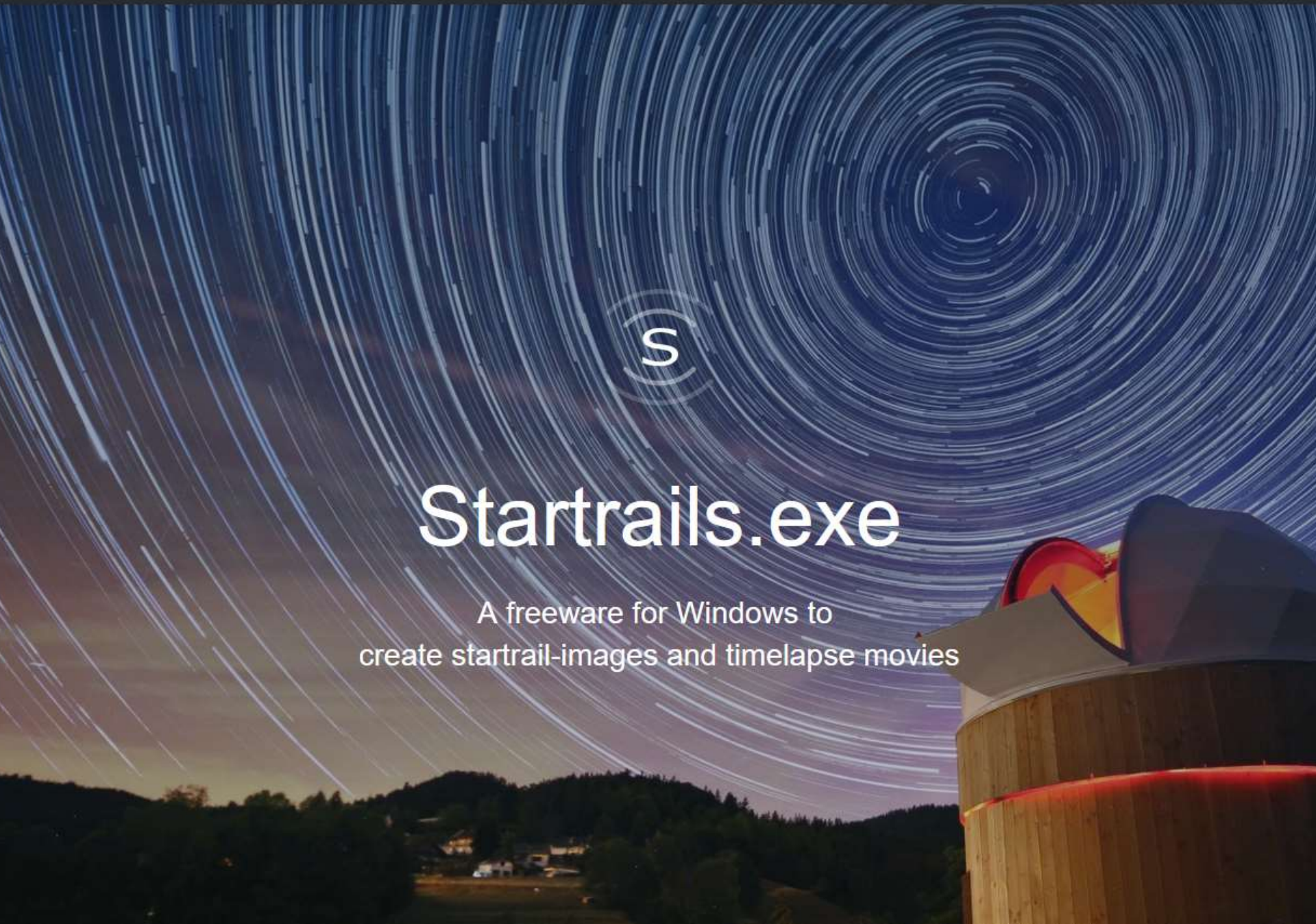


Astrophotography

Dr Das Baskill
University of Sussex


Time-lapse
Photography


Movement
Moon trails



Startrails.exe

A freeware for Windows to
create startrail-images and timelapse movies

Startrails Version 2.3

File Build Options ?

Donate

Images

Files:

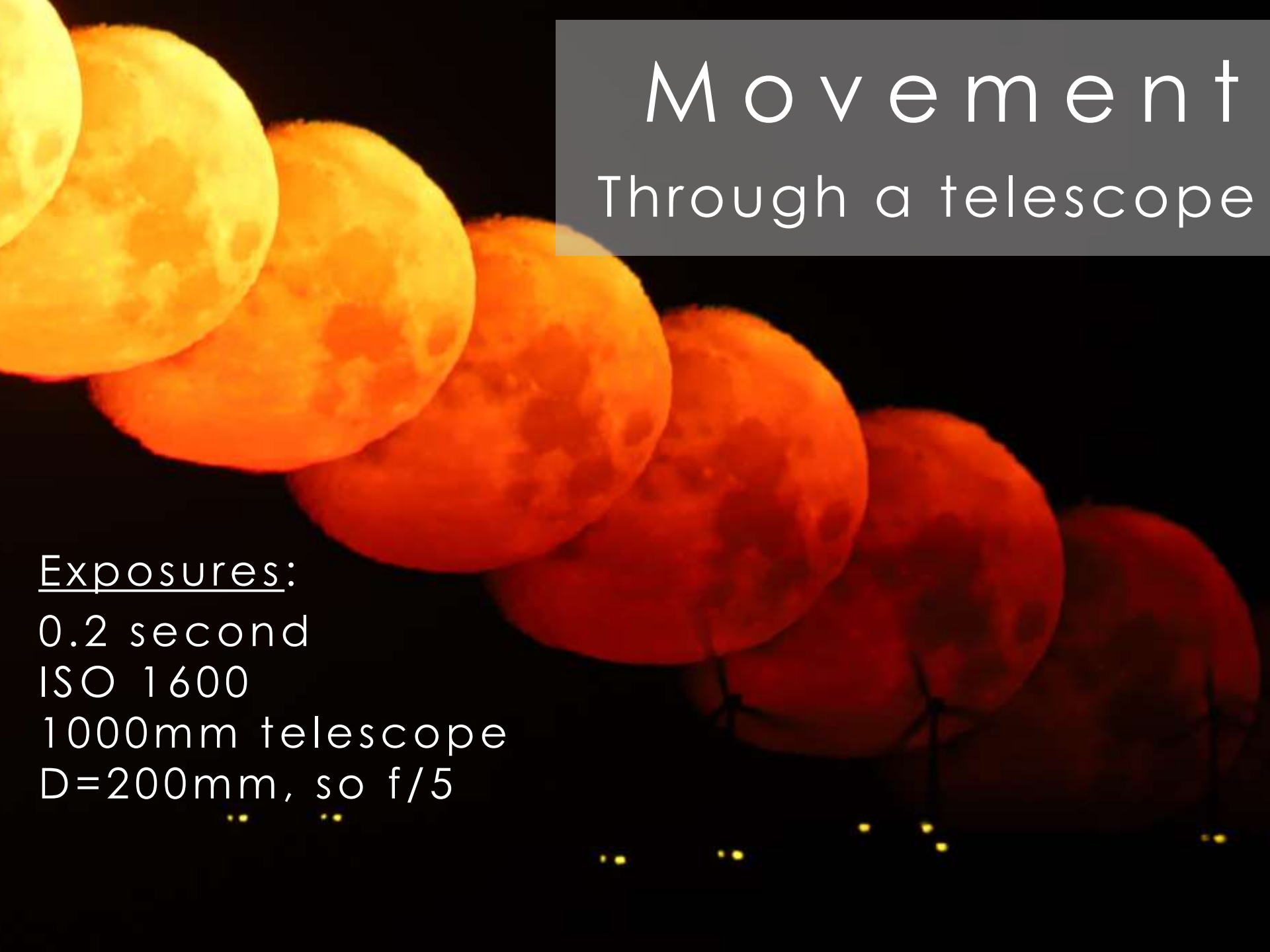
- IMG0001.jpg
- IMG0002.jpg
- IMG0003.jpg
- IMG0004.jpg
- IMG0005.jpg
- IMG0006.jpg
- IMG0007.jpg
- IMG0008.jpg
- IMG0009.jpg
- IMG0010.jpg
- IMG0011.jpg
- IMG0012.jpg
- IMG0013.jpg
- IMG0014.jpg
- IMG0015.jpg

Darkframes

Files

Selection | Foreground (averaged) | Result


Movement
Moon trails
Stacked using startrails.de
Exposures:
1 second
ISO 1000
f/8
300mm lens



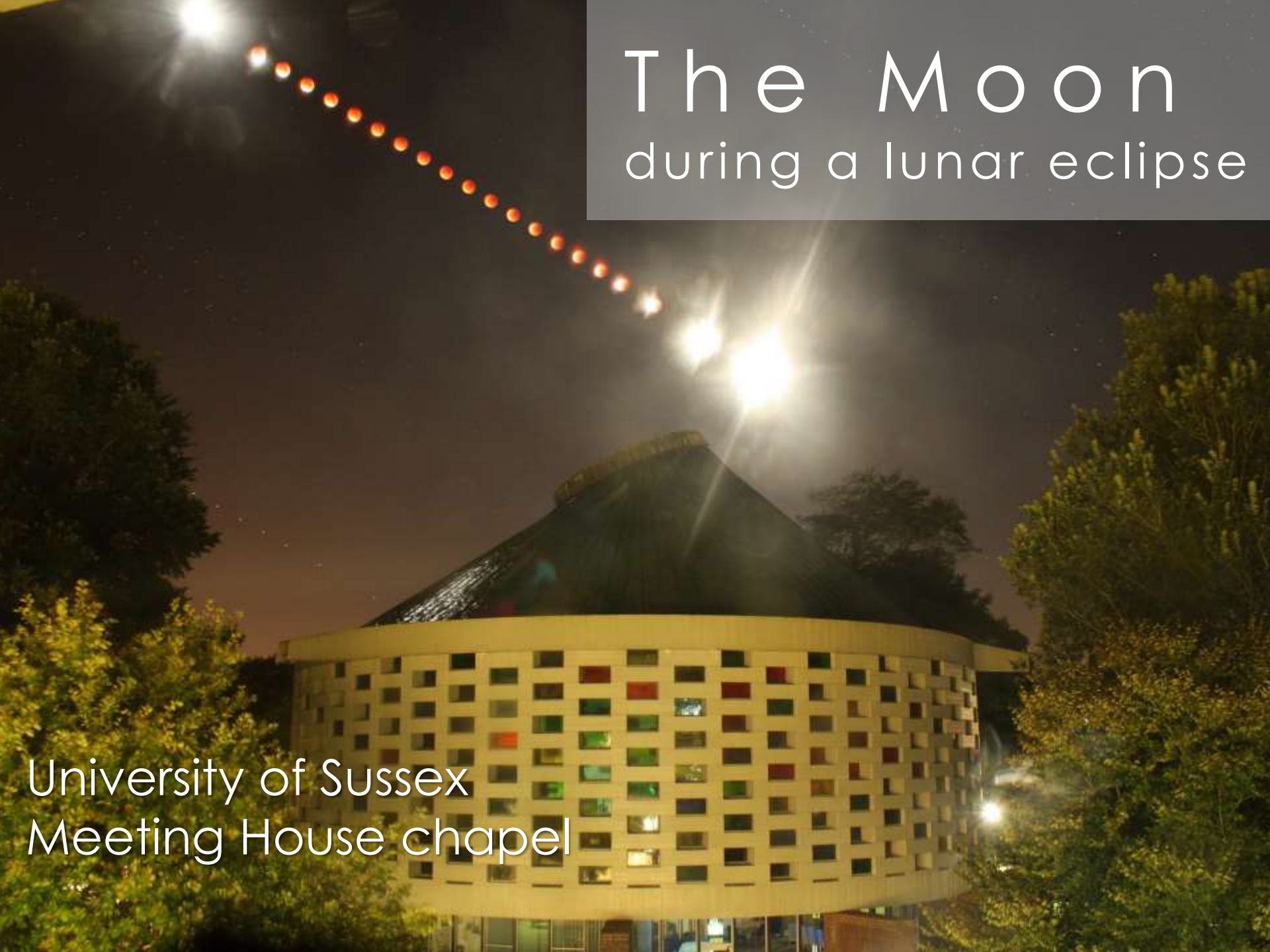
Movement

Through a telescope

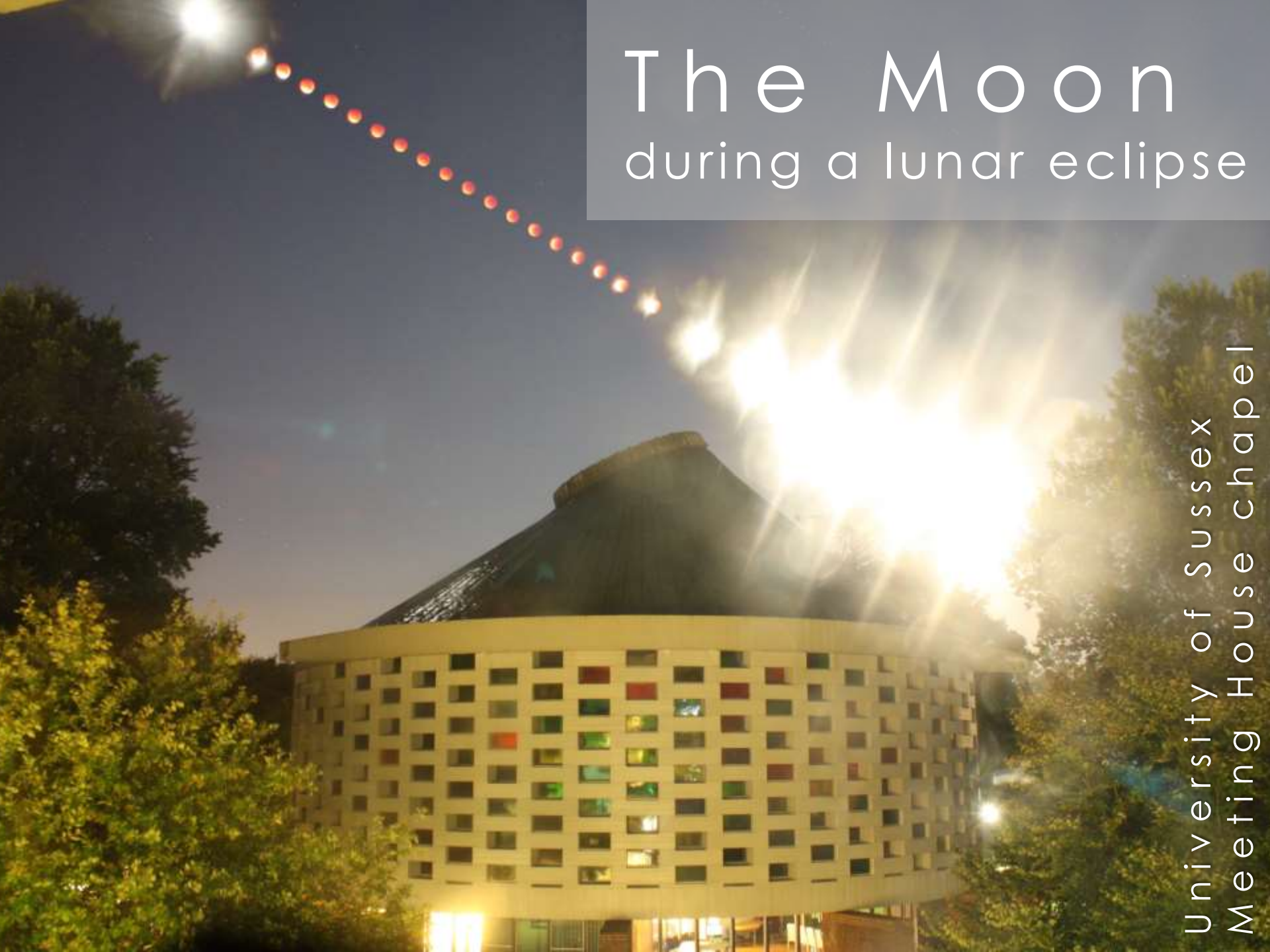
Exposures:

0.2 second
ISO 1600
1000mm telescope
D=200mm, so f/5

Planning with Stellarium and a map


The Moon
during a lunar eclipse
University of Sussex
Meeting House chapel

The Moon
during a lunar eclipse



University of Sussex
Meeting House chapel

The Moon
during a lunar eclipse

University of Sussex
Meeting House chapel


Movement
Star trails

Movement

Star trails

Exposures:

30 seconds
f/9
ISO 3200
Repeated for 8 hours

At f/9, both badger & stars are in focus

Movement

Star trails

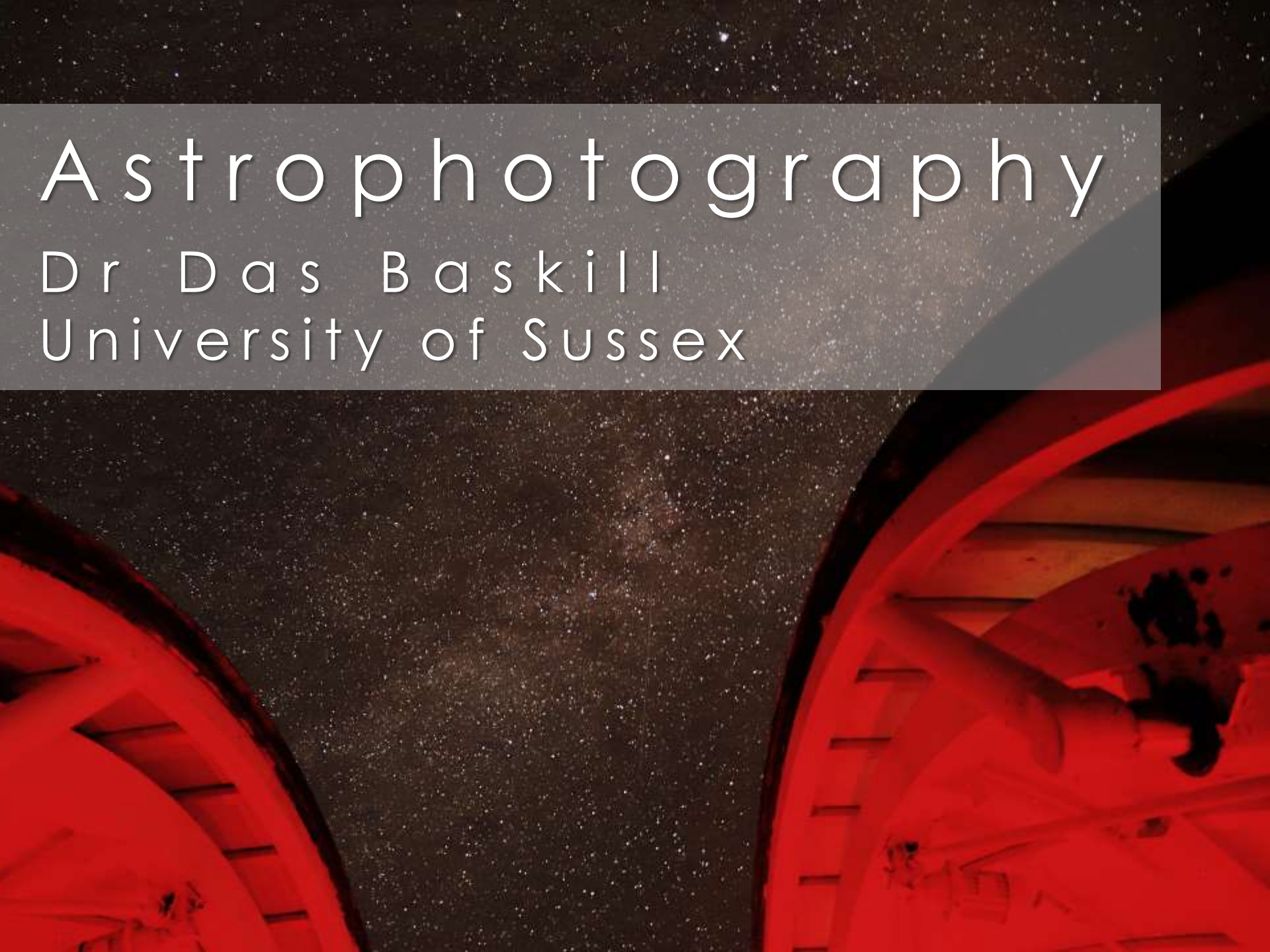

Mauna Kea
Hawai'i


Mauna Kea
Hawai'i


Mauna Kea
Hawai'i
~50x 30 second photographs, aligned & stacked


Mauna Kea
Hawai'i


Mauna Kea
Hawai'i



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