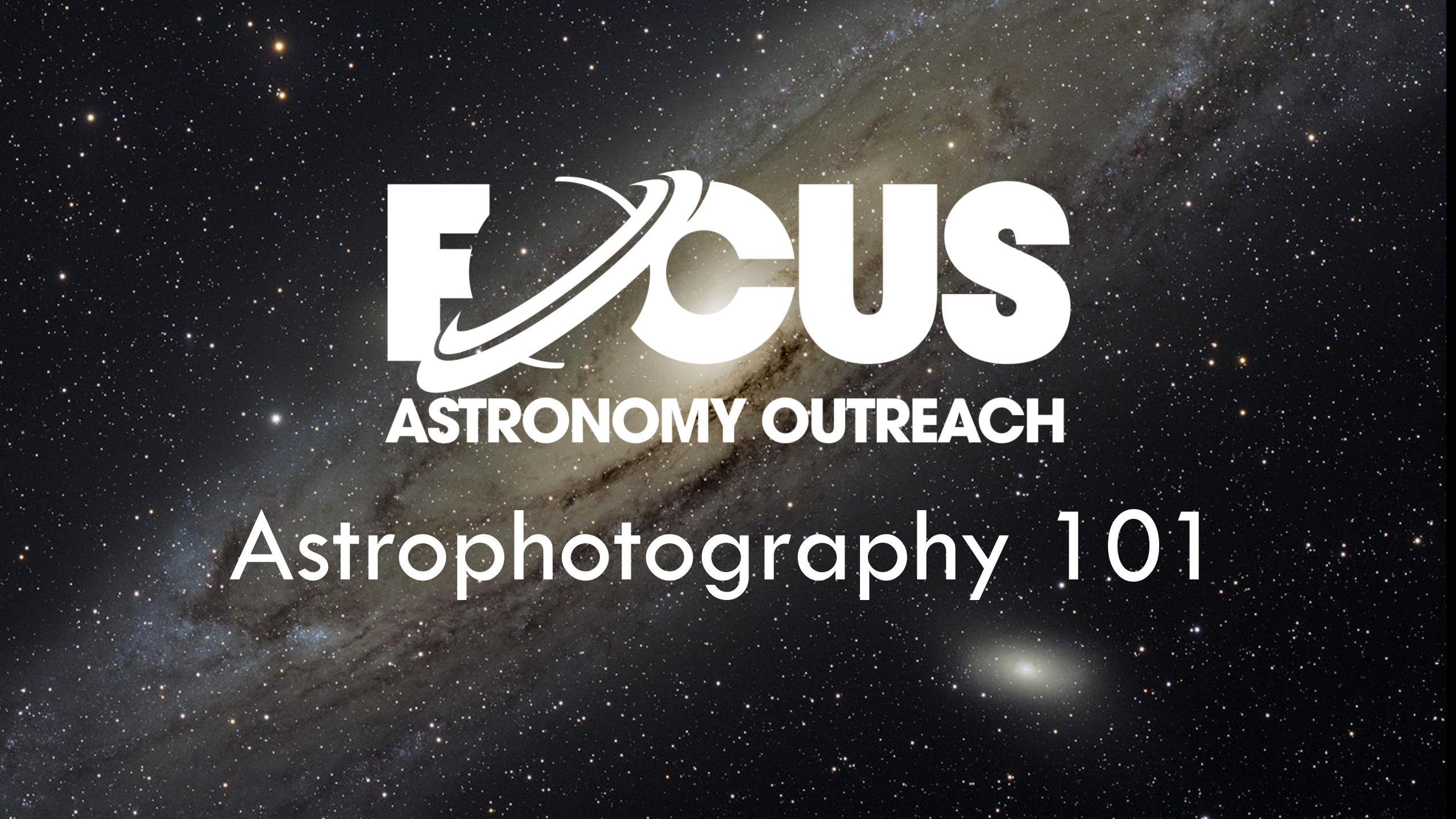

Astrophotography 101

What is Astrophotography?

What is Astrophotography?

What is Astrophotography?

Photographing celestial phenomena & bodies

What is Astrophotography?

Photographing celestial phenomena & bodies

Branches of astrophotography:

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Branches of astrophotography:

- Nightscape photography

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What is Astrophotography?

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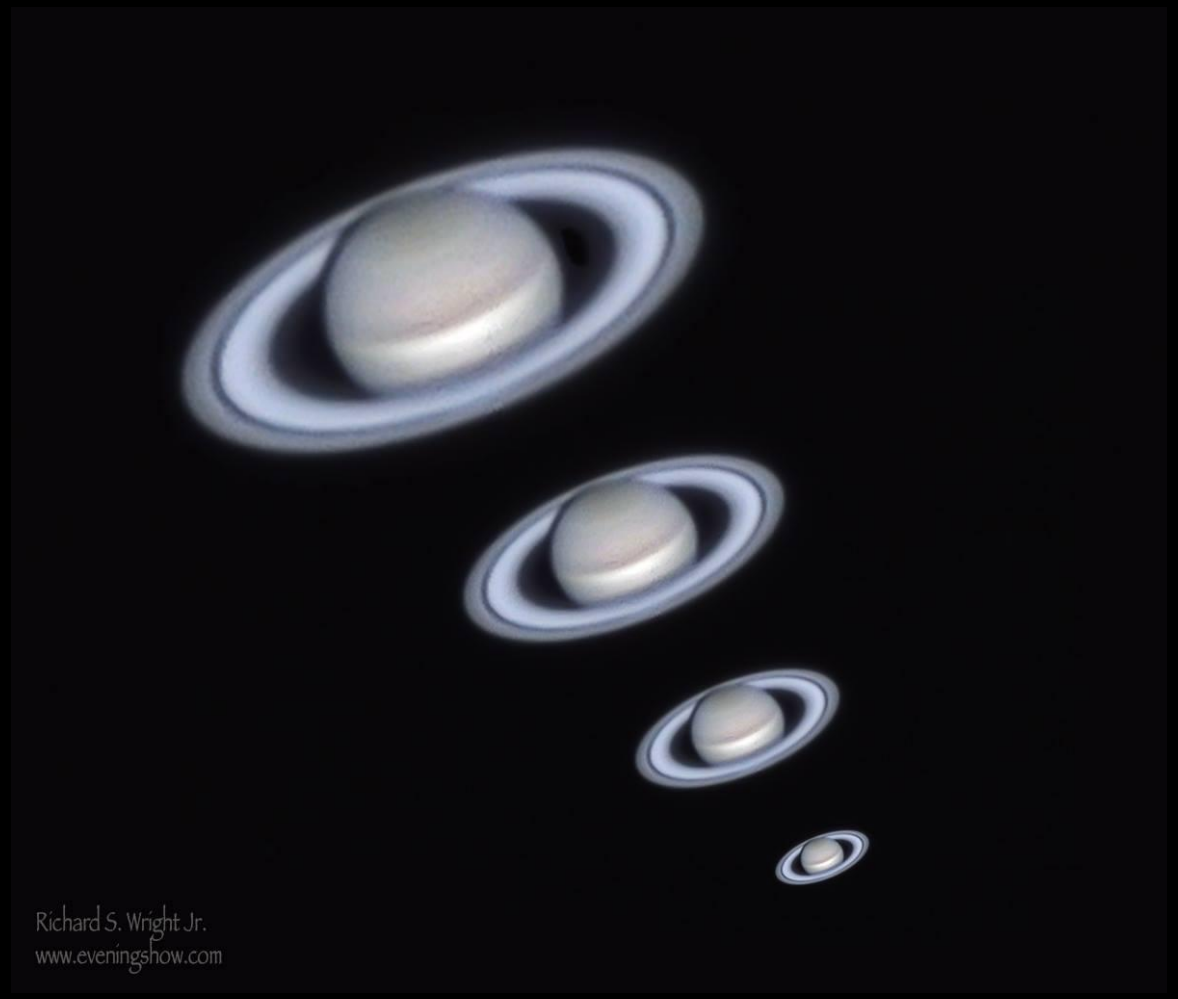
Branches of astrophotography:

- Nightscape photography
- Eclipse photography
- Lunar/Planetary



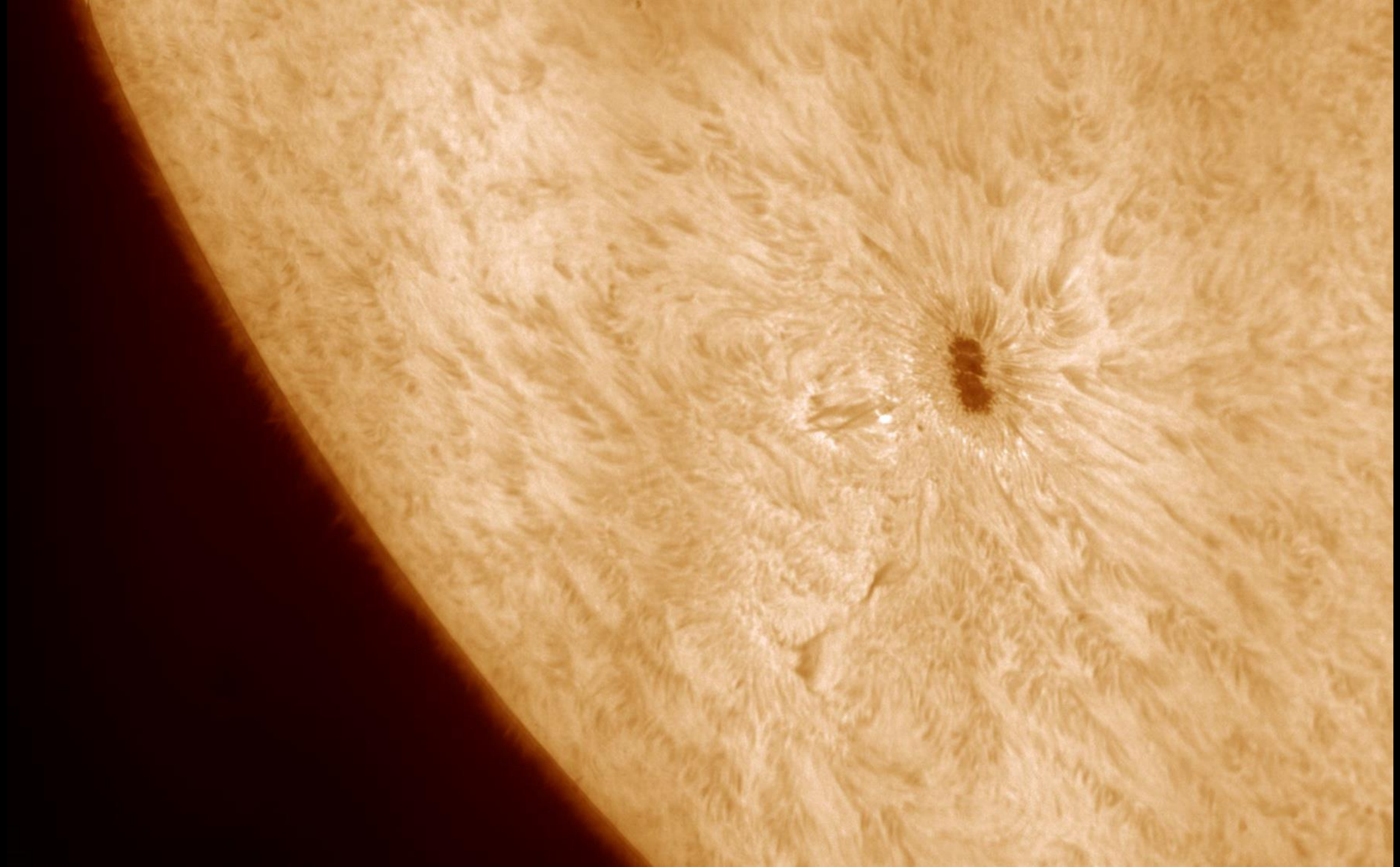
Images By: Richard Wright

What is Astrophotography?

Photographing celestial phenomena & bodies

Branches of astrophotography:

- Nightscape photography
- Eclipse photography
- Lunar/Planetary
- Solar



What is Astrophotography?

Photographing celestial phenomena & bodies

Branches of astrophotography:

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- Lunar/Planetary
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- Deep Sky

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Photographing celestial phenomena & bodies

Branches of astrophotography:

- Nightscape photography
- Eclipse photography
- Lunar/Planetary
- Solar
- Deep Sky

Each branch of has its own approach and methods

Getting Started

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- Head to a dark location and start shooting

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- Hook your camera or phone up and shoot the moon

Experiment with what you have first, make small investments if needed

Nightscapes

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Nightscape photography is a fun and easy way to dive into astrophotography

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Modern DSLRs/mirrorless cameras are excellent for this work

Basic equipment is needed to achieve a good shot

Provides a good foundation for advanced deep sky astrophotography

Getting Started

Getting Started

- Camera (DSLR/mirrorless)
- Wide angle lens
- Tripod

Getting Started

- Camera (DSLR/mirrorless)
- Wide angle lens
- Tripod

- Become familiar with your equipment before heading out.

Getting Started

Three things to know on your camera:

1. How to adjust exposure

2. How to adjust ISO

3. How to adjust aperture

Camera Mode

Manual Mode

Manual Mode

- ISO
- Aperture
- Exposure

ISO


M-Fn
WB
DRIVE·AF
ISO
AF-ON

ISO

- Sensitivity of your camera sensor.
  - Higher the number, the more sensitive.
  - Lower the number, the less sensitive.
- Higher ISO produces nosier images.
- Recommend ISO settings:
  - Between 1600 and 6400 (or higher)


ISO 1600
f/2.8 30 seconds
ISO 6400
f/2.8 30 seconds
ISO 12500
f/2.8 30 seconds

Exposure

Exposure

- How long the camera is collecting light
- Longer the exposure, the more light the camera collects.
- Recommend exposure settings:
  - 30 seconds or more
  - Exposures longer than 30 seconds usually need a tracking mount to prevent star blurring.


5 seconds
f/2.8 ISO 6400
15 seconds
f/2.8 ISO 6400
30 seconds
f/2.8 ISO 6400

Aperture

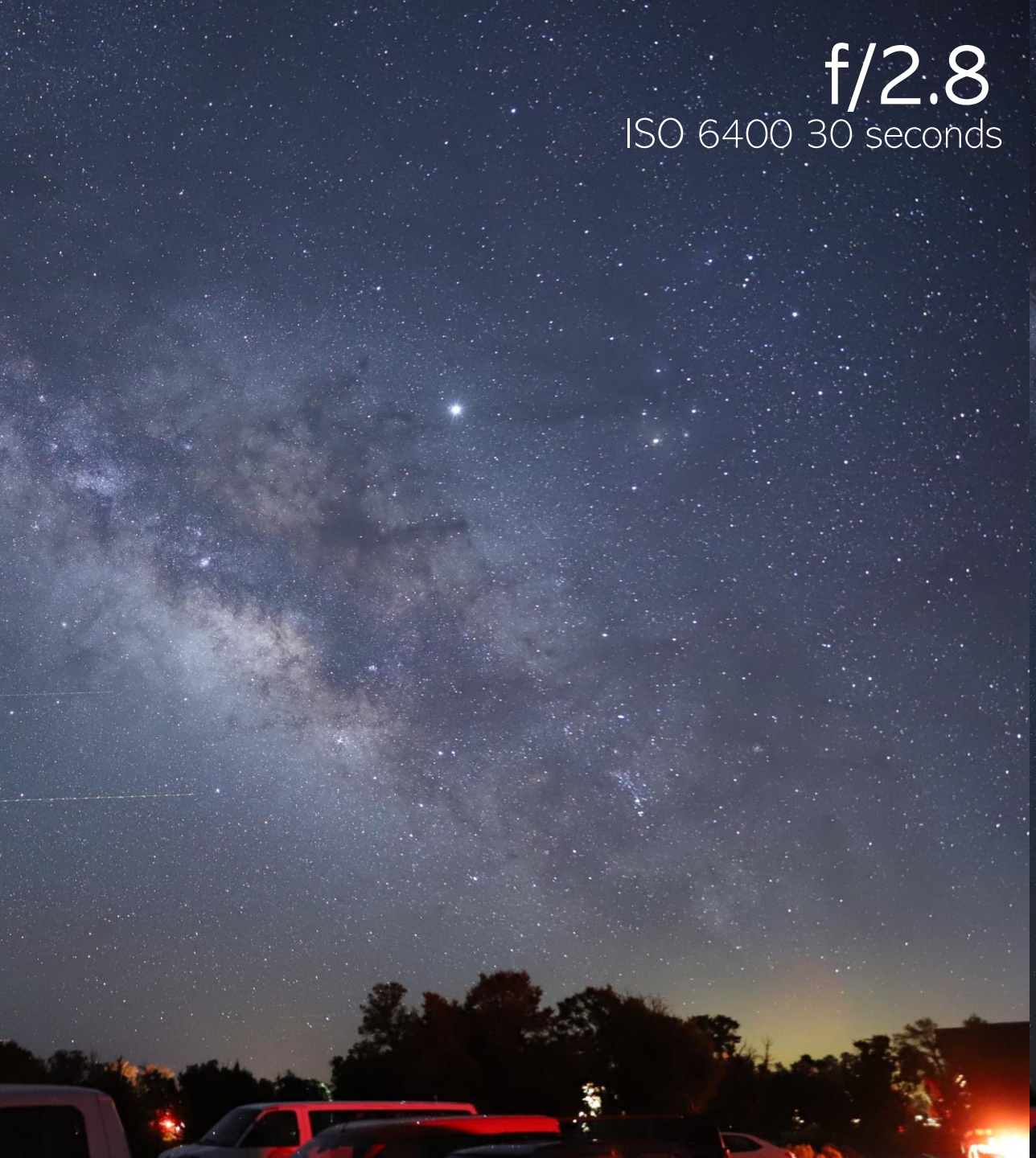
Aperture

- How wide the lens is open to collect light
- Wider the aperture, the more light.
- Lens aperture is usually seen as an F-Ratio.
  - Lower the number, the wider the aperture of the lens.
  - Most kit lenses range between f/3.5 to f/4
  - Some lenses go as low as f/1.2
- Recommend aperture settings:
  - As wide as your lens will allow.


EF 24-105mm 1:4 L IS USM


24-105mm 1:4 L
CANON EF LENS
φ77mm
CANON ZOOM LENS EF 24-70mm 1:2.8 L II USM
φ82mm


24-105mm 1:4 L
CANON EF LENS
φ77mm
CANON ZOOM LENS EF 24-70mm 1:2.8 L II USM
φ82mm
f/2.8 lens collects 89%
more light than an f/4


f/2.8
ISO 6400 30 seconds


f/4
ISO 6400 30 seconds

Focal Length

- Wider the better

- 14mm to 35mm
  - Most kit lenses at 18-55mm or 24-105mm


24mm f/2.8
30 seconds ISO 6400
50mm f/2.8
30 seconds ISO 6400
70mm f/2.8
30 seconds ISO 6400

Three things to remember.

- ISO: sensitivity of the sensor

At least 1600 to 6400. Higher if camera allows.

- Exposure: how long the camera shutter is open

10 seconds to start, pushing up to 30 seconds.

- Aperture: how wide the lens is to collect light

Widest the lens will allow. Usually f/3.5 for kit lenses.

Side Notes

- Set you lens to manual focus mode.
- Turn off image stabilization (if your lens has this).
- Set the camera to live view mode to aid in focusing.

Have fun

Be creative

Don’t worry, its digital

Tracking & Mounts

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The Earth moves causing the sky to move

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During a long exposure image, the movement will cause your image to blur

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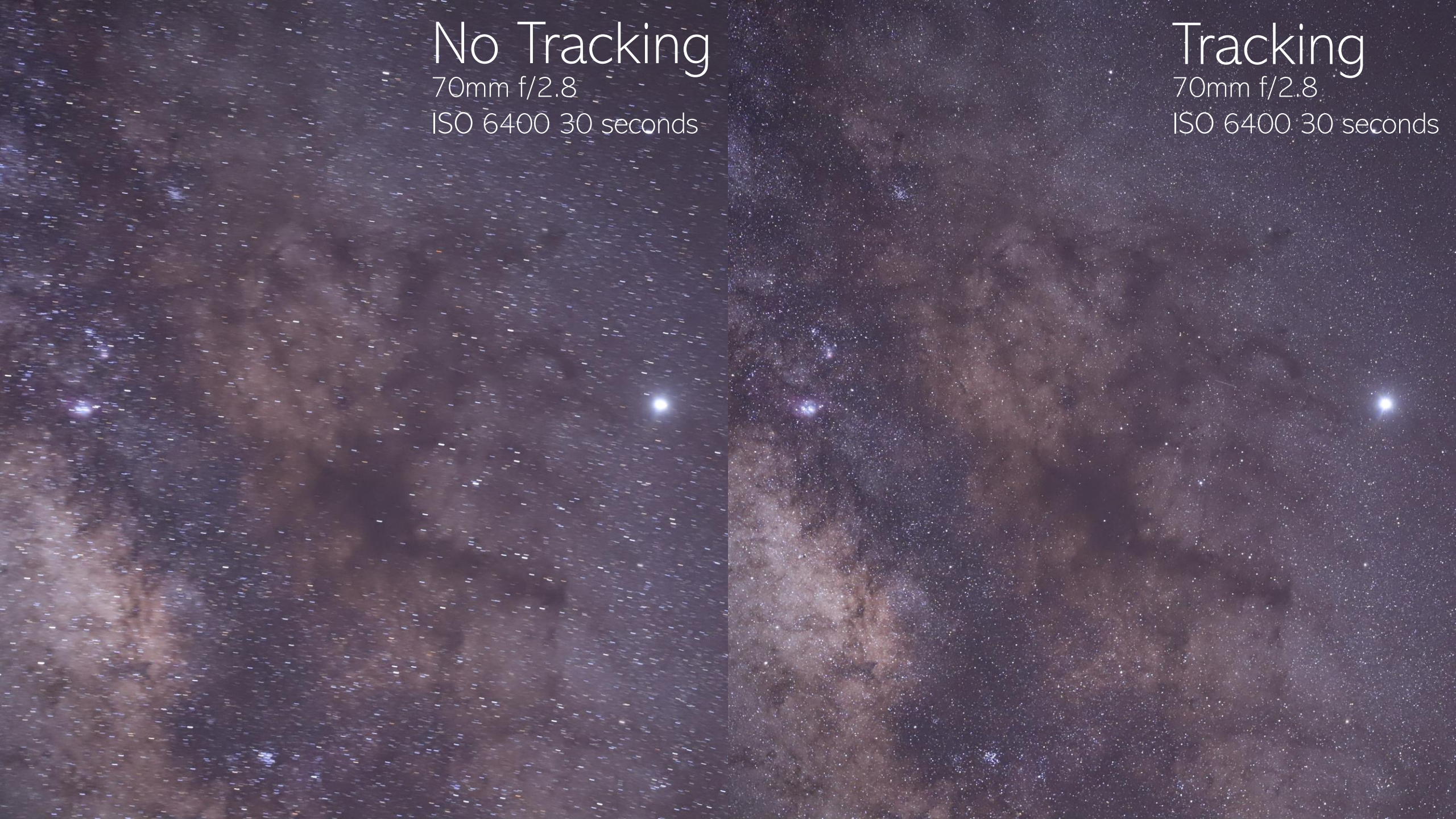
A special mount is required to allow your camera or telescope to follow the stars


No Tracking
70mm f/2.8
ISO 6400 30 seconds
Tracking
70mm f/2.8
ISO 6400 30 seconds

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There are two major types of mount:

- Alt-Az
- Equatorial

Alt-Az Vs. Equatorial

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- Alt-Az
- Equatorial (EQ)

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However, the way a mount tracks is an important thing to note

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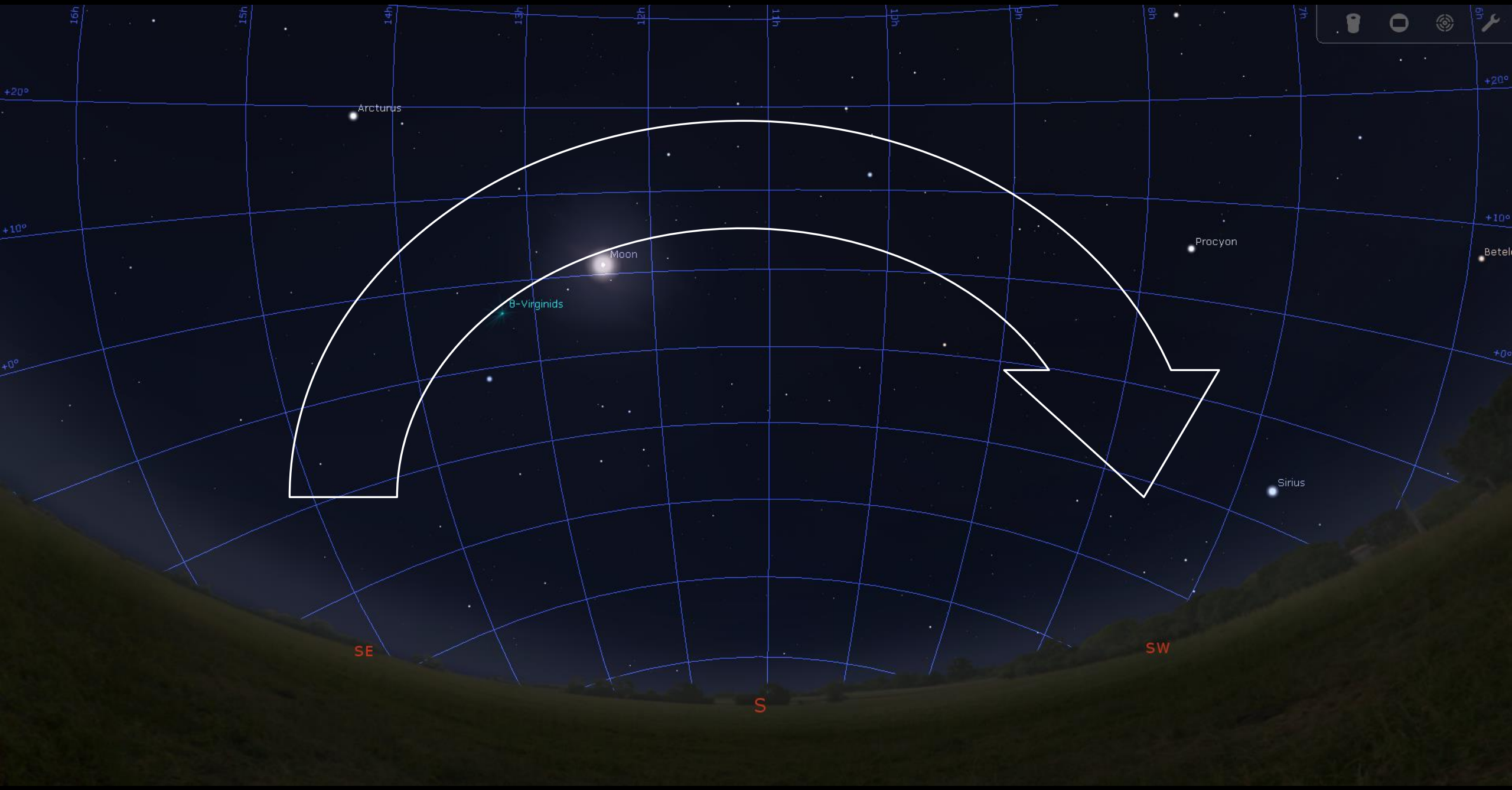
However, the way a mount tracks is an important thing to note

Stars travel in an arch shape across the sky, rising in the east, setting in the west


16h
15h
14h
13h
12h
11h
10h
9h
8h
7h
6h
+20°
+10°
+0°
Arcturus
Moon
Procyon
Betel
B-Virginids
Sirius
SE
SW
S

Alt-Az

Alt-Az

Alt-Az track stars in a stair step pattern

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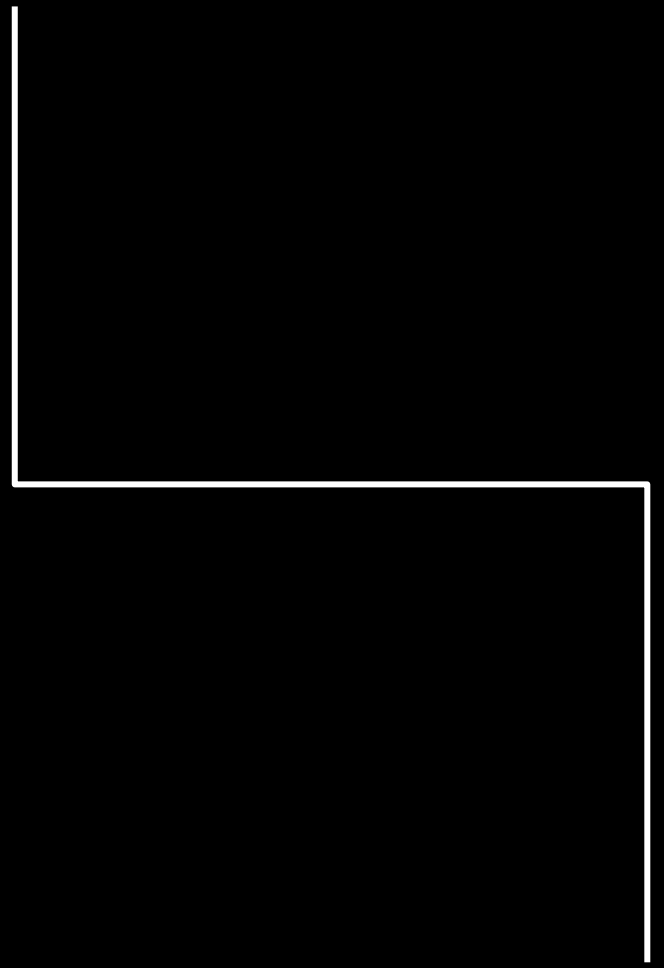
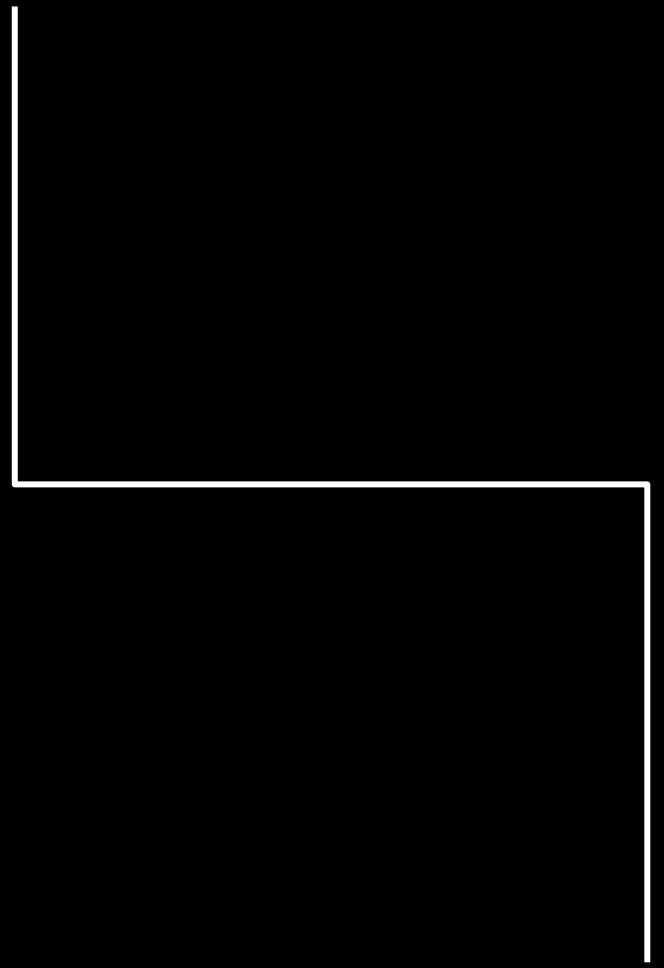
Alt-Az track stars in a stair step pattern



Alt-Az

Alt-Az track stars in a stair step pattern

Slowly moving over and up to track the object

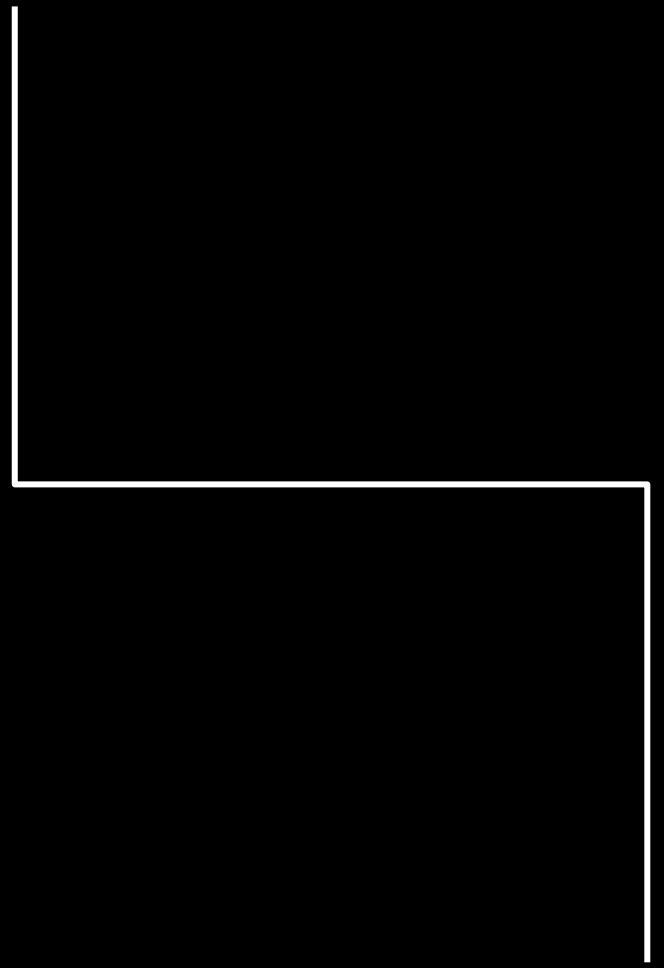


Alt-Az

Alt-Az track stars in a stair step pattern

Slowly moving over and up to track the object

Visually, little change is actually seen



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Alt-Az track stars in a stair step pattern

Slowly moving over and up to track the object

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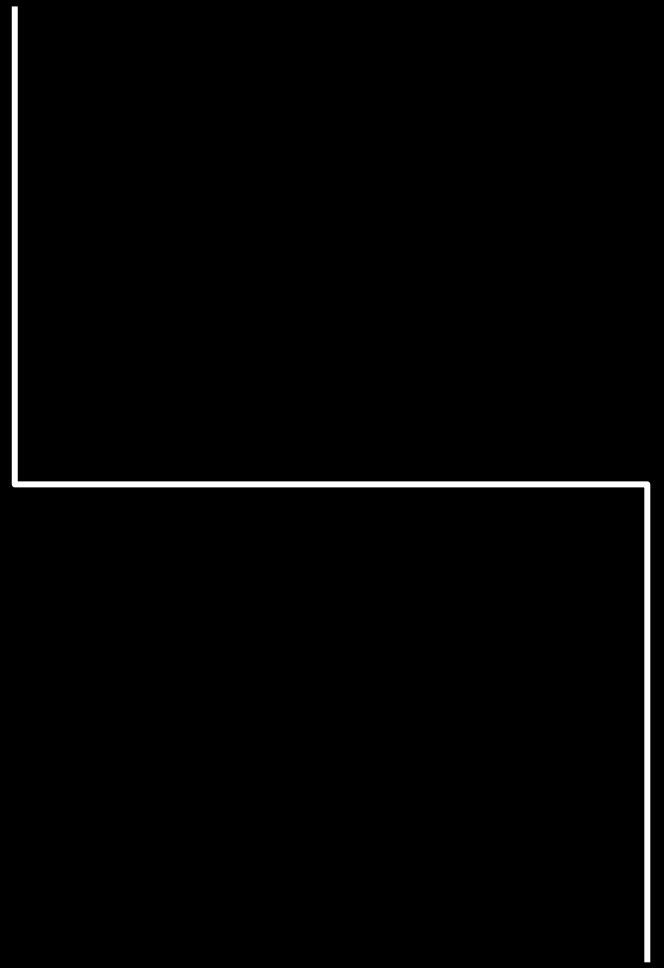
During long exposures stars will blur at the edge



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Alt-Az track stars in a stair step pattern

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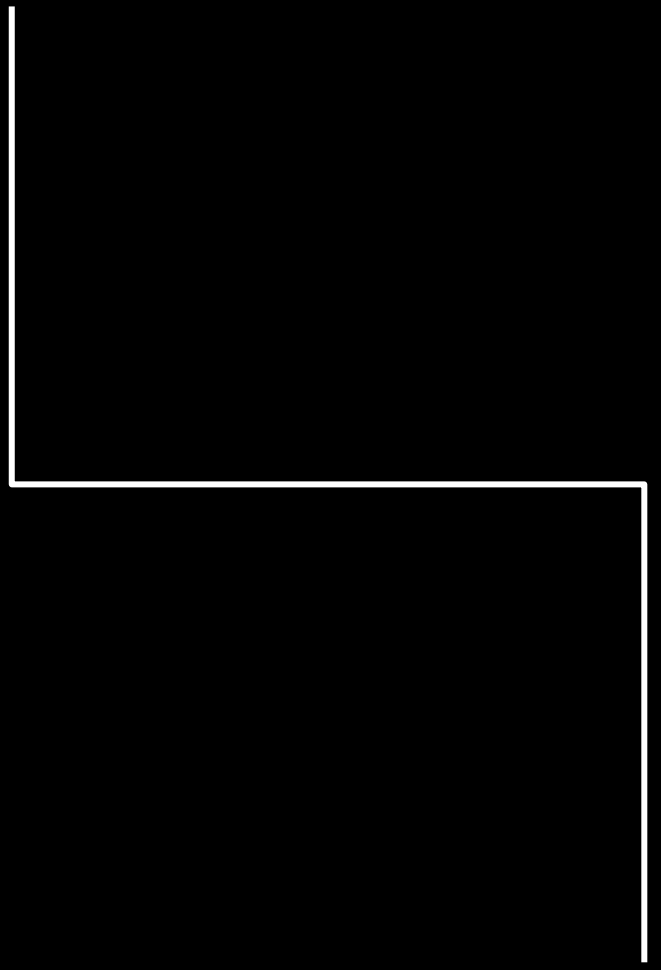
During long exposures stars will blur at the edge

This is due to the stars moving in their natural arch shape, rotating as they move



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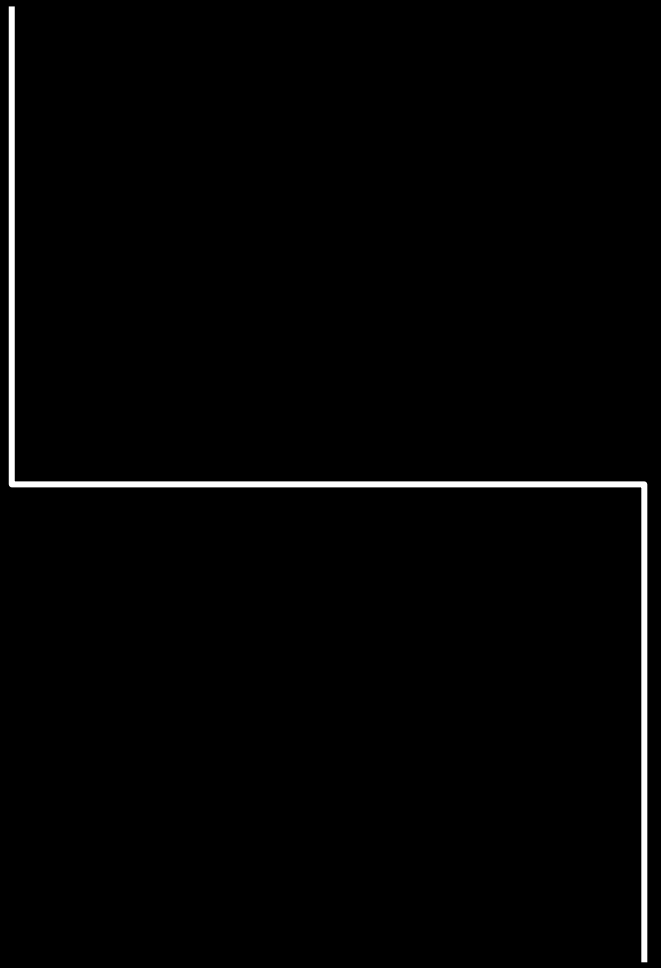
- Field Rotation



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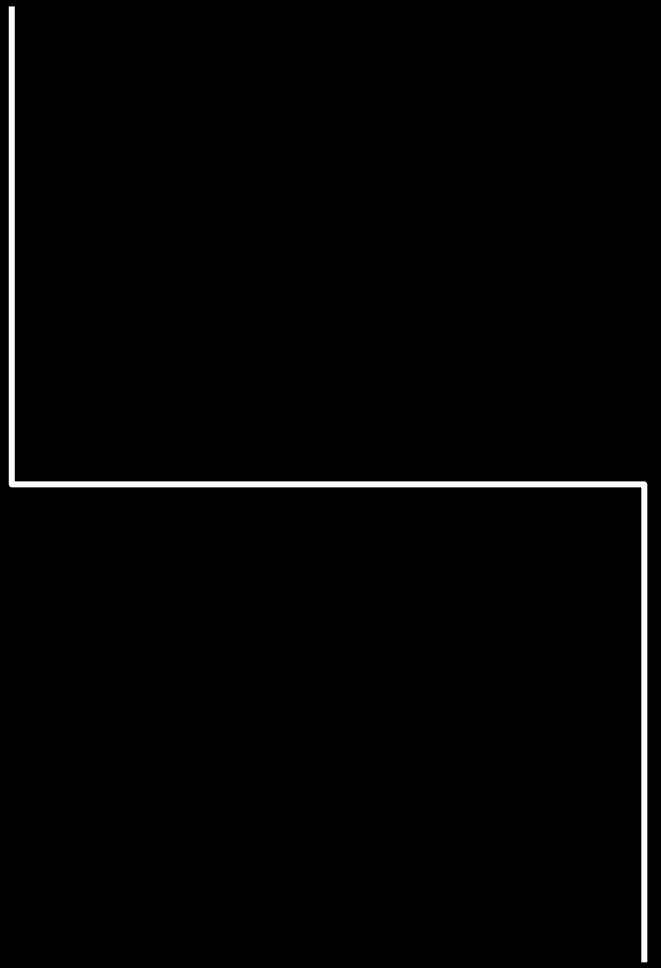
- Field Rotation

Limits Alt-Az mounts to short exposures



EQ

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EQ mounts are aligned with the celestial pole

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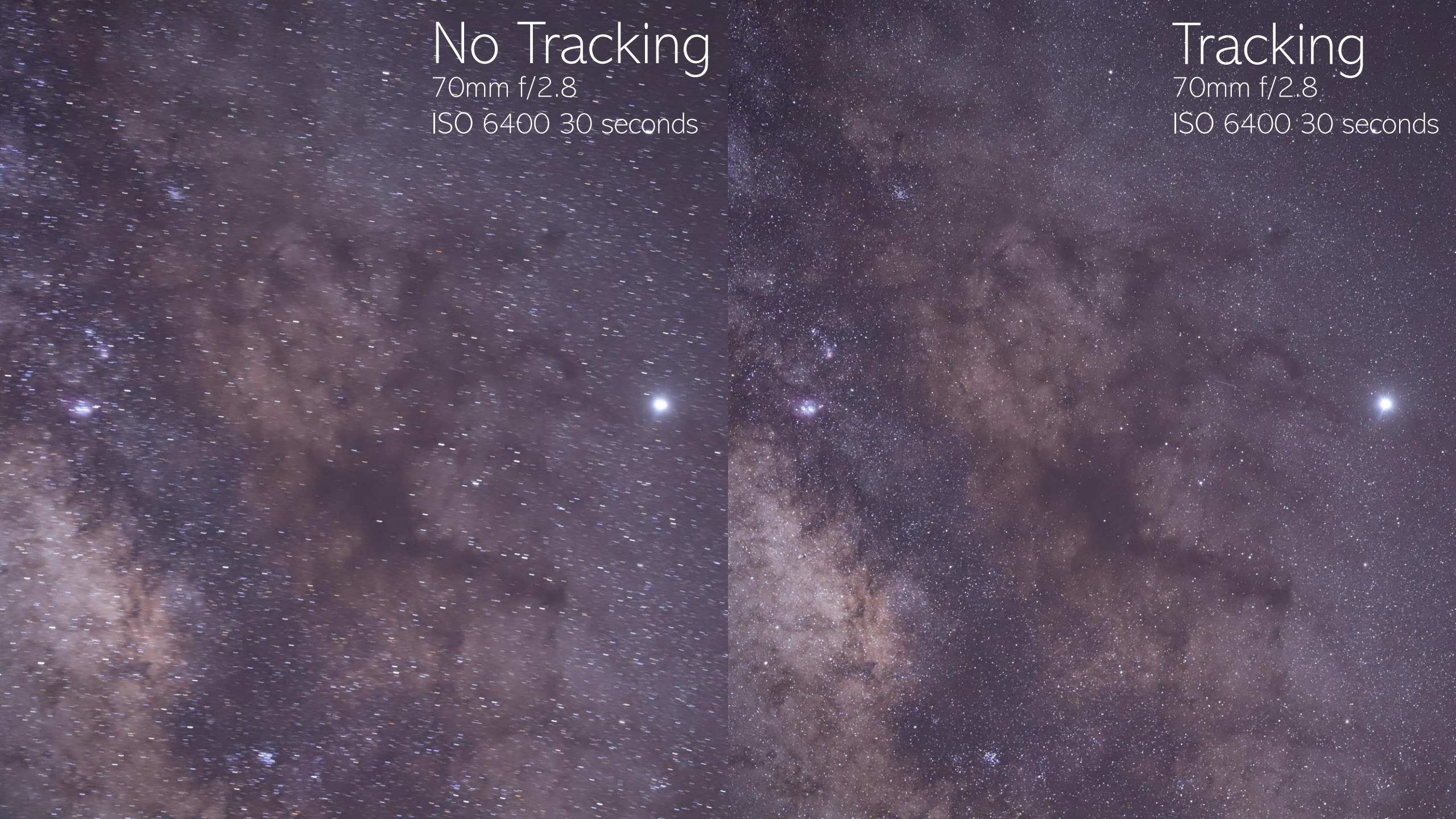
EQ mounts are ideal for astrophotography


No Tracking
70mm f/2.8
ISO 6400 30 seconds
Tracking
70mm f/2.8
ISO 6400 30 seconds

EQ

EQ

EQ mounts are aligned with the celestial pole

- Polaris, North Star

This allows the mount to track in the same method that the stars move

Allowing for long exposures without field rotation

EQ mounts are ideal for astrophotography

EQ mounts come in various sizes for various applications

EQ: Continued

The mount is the most important part of a photographic system

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You want to know the weight of the equipment you intend to mount

EQ: Continued

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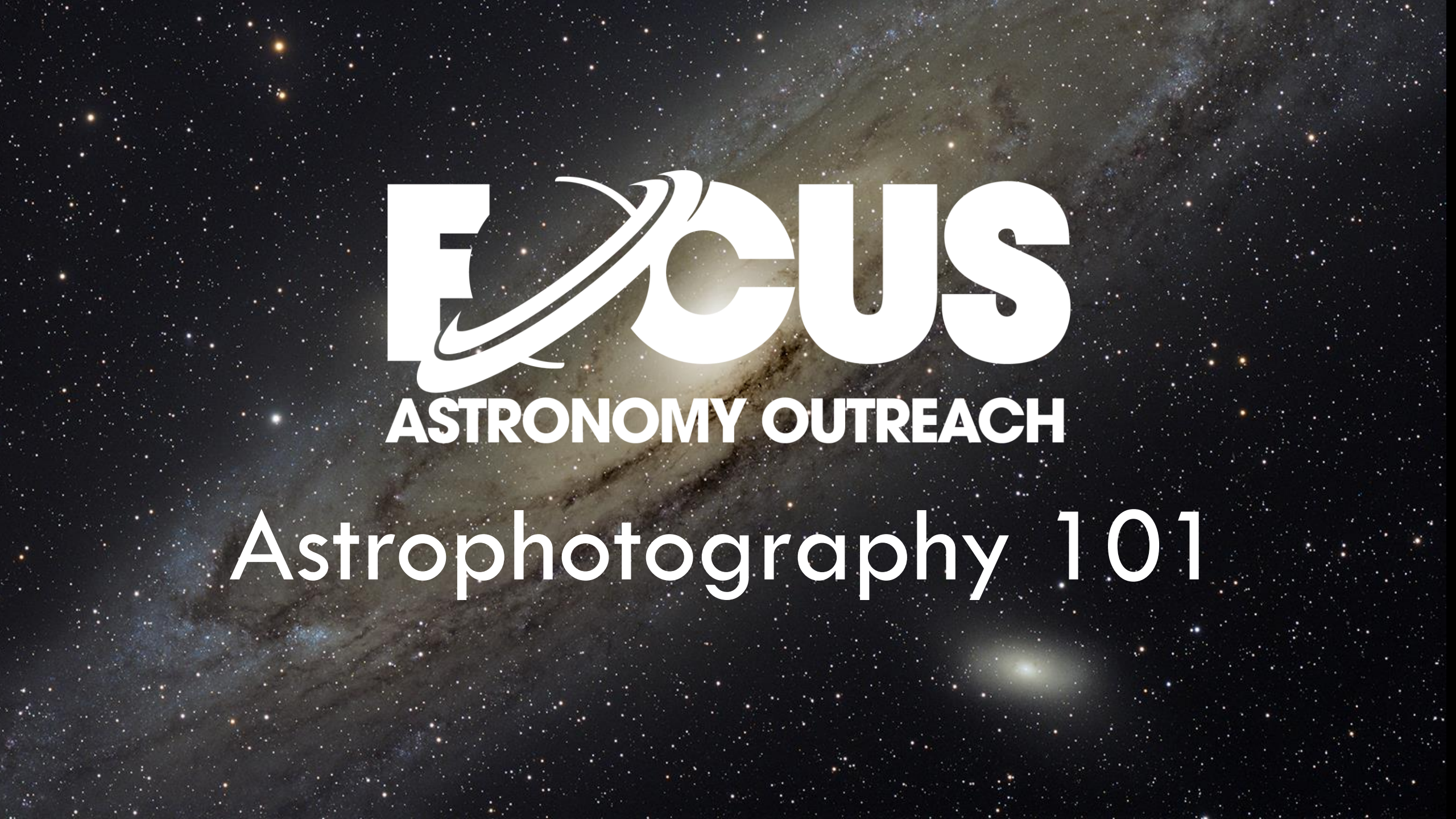
You want to know the weight of the equipment you intend to mount

Longer focal length optics generally need a large mount as well



Astrophotography 101

Optics

Basic Terminology

Basics Terminology

<u>Aperture:</u>
Diameter of the main optic (lens or mirror)

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- Brighter images, fainter objects can be seen

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- Larger the aperture the more light is collected
- Brighter images, fainter objects can be seen
- Higher resolution, smaller details can be resolved

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<u>Aperture Jumps:</u>

Goes off surface area not diameter.

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<u>Aperture Jumps:</u>

Goes off surface area not diameter.

- 4” = 50 square inches
- 6” = 113 square inches (225%)
- 8” = 201 square inches (78%)
- 10” = 314 square inches (56%)

Basics Terminology

Aperture:

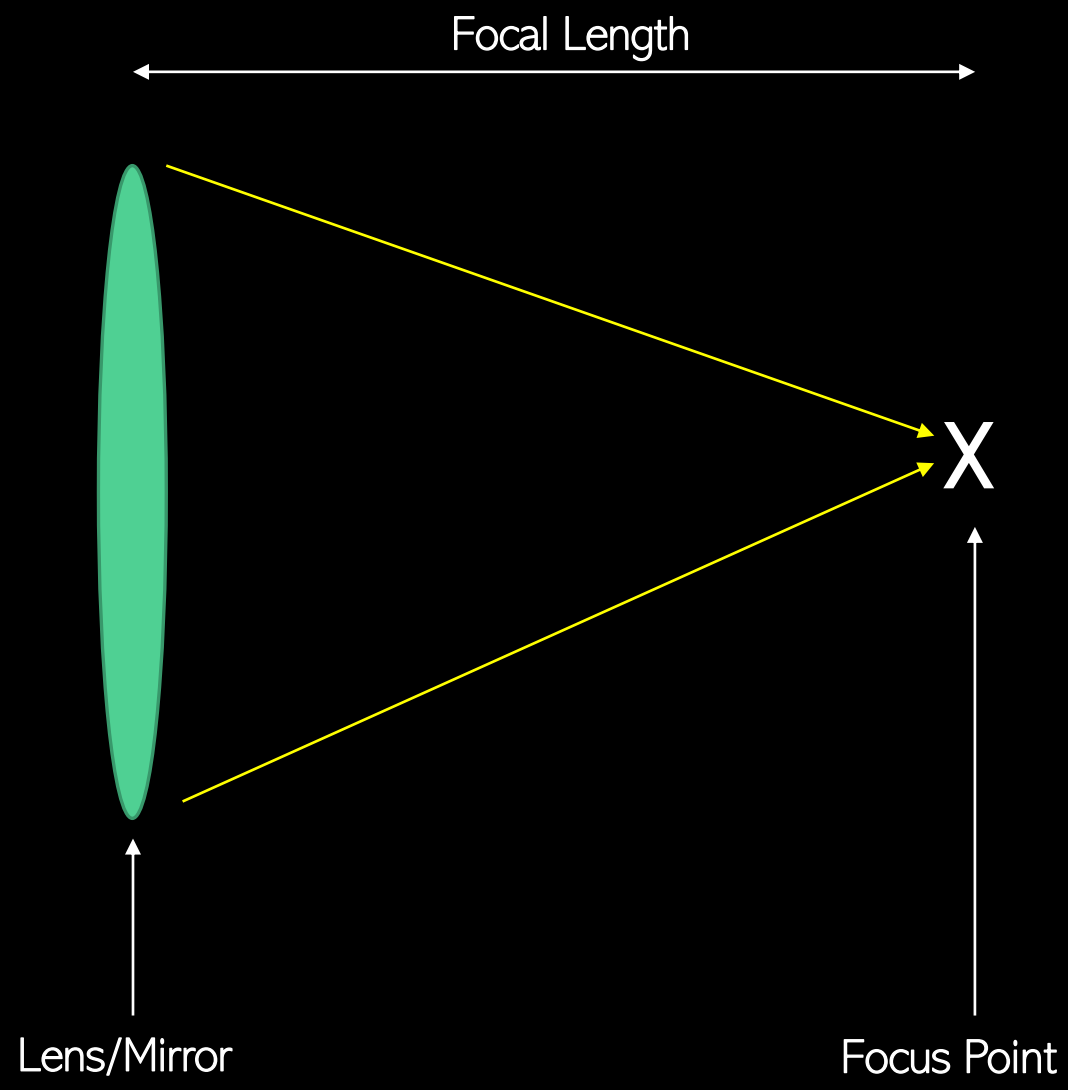
Diameter of the main optic (lens or mirror)

Focal Length:

Basics Terminology

<u>Aperture:</u>
Diameter of the main optic (lens or mirror)

<u>Focal Length:</u>
Distance to the focus point from the main optic

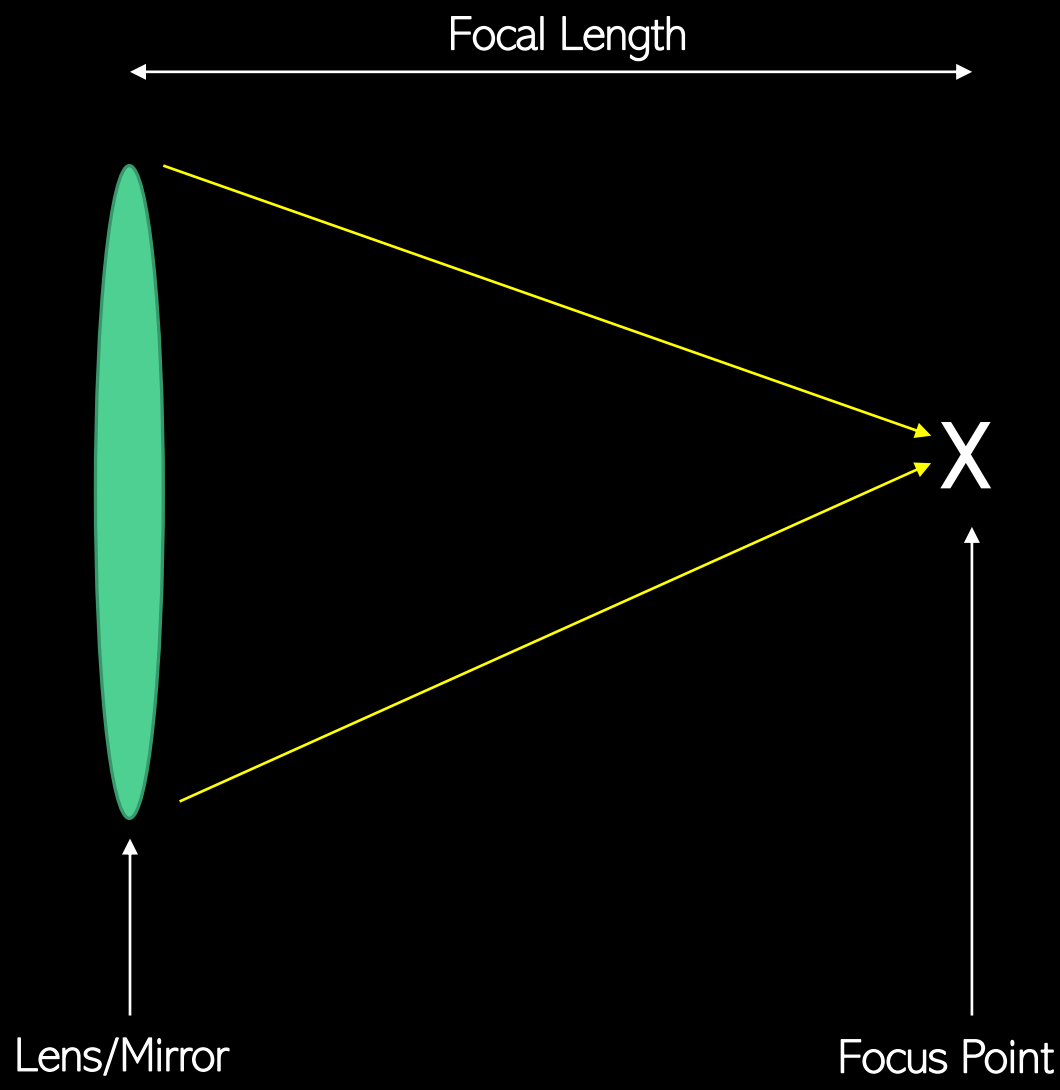


Basics Terminology

<u>Aperture:</u>
Diameter of the main optic (lens or mirror)

<u>Focal Length:</u>
Distance to the focus point from the main optic

- Longer focal length, narrower field of view



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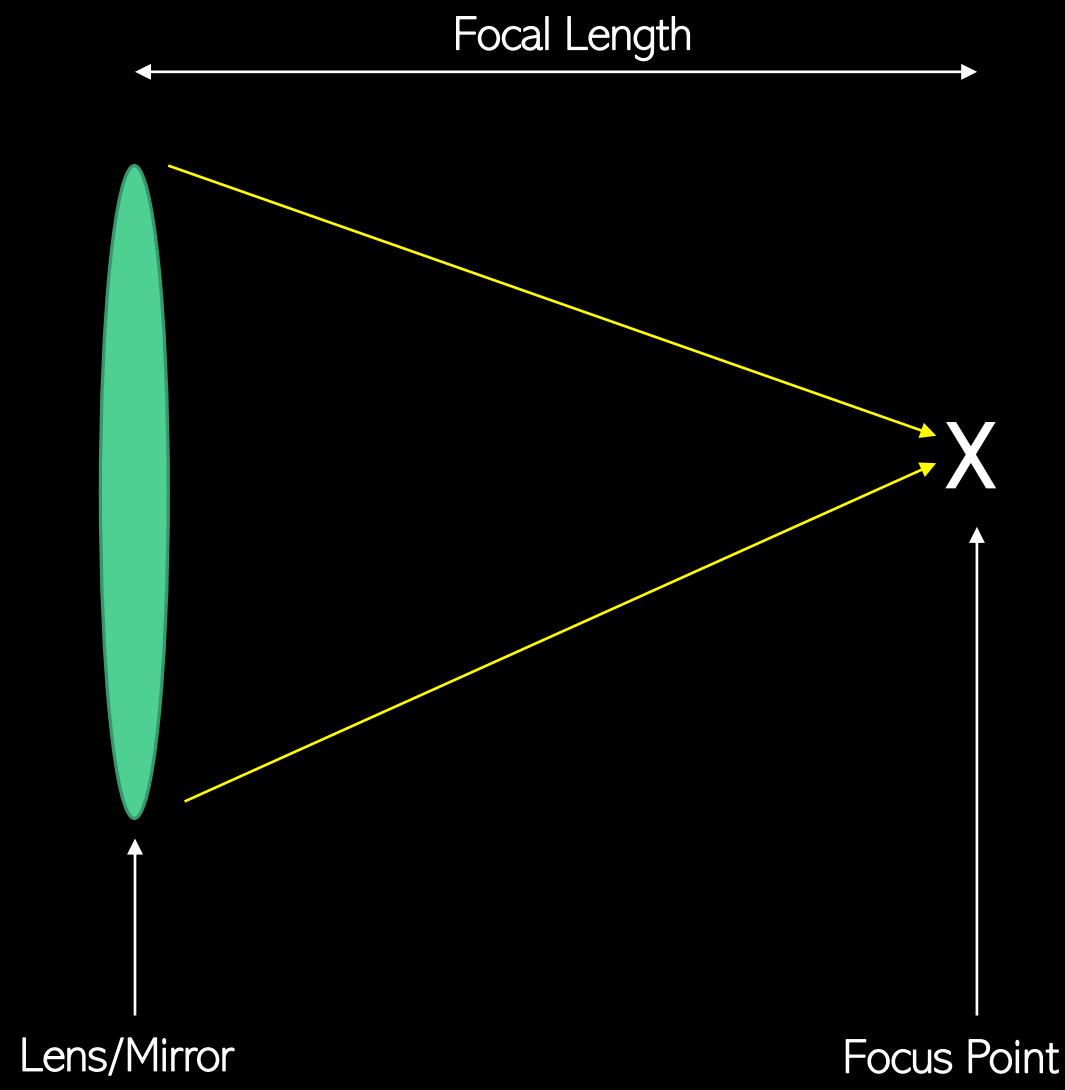
- Longer focal length, narrower field of view
- Shorter focal length, wider field of view



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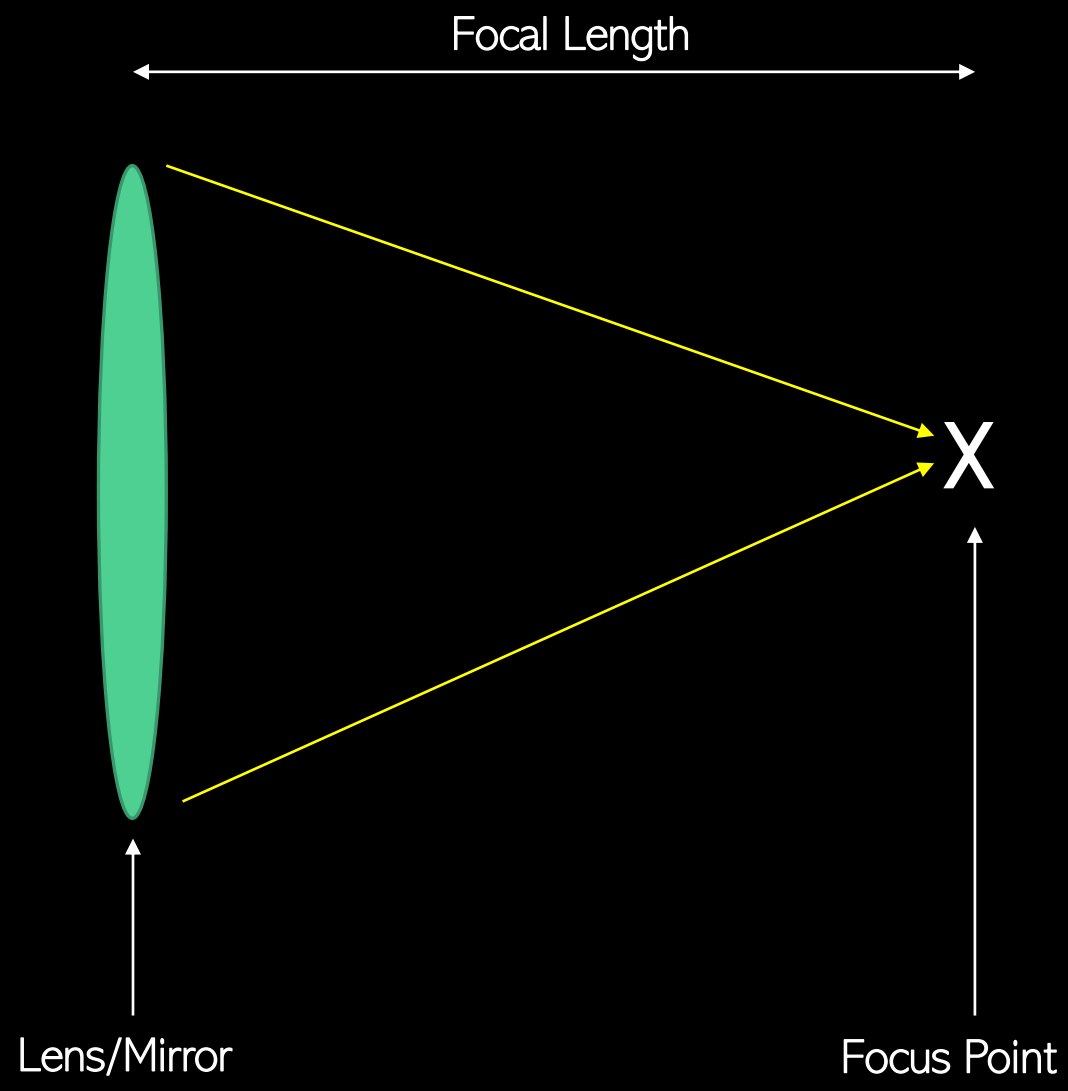
Distance to the focus point from the main optic

- Longer focal length, narrower field of view
- Shorter focal length, wider field of view
- Field of view can also be affected by the size of your camera sensor



Basics Terminology

Aperture:
Diameter of the main optic (lens or mirror)

Focal Length:
Distance to the focus point from the main optic

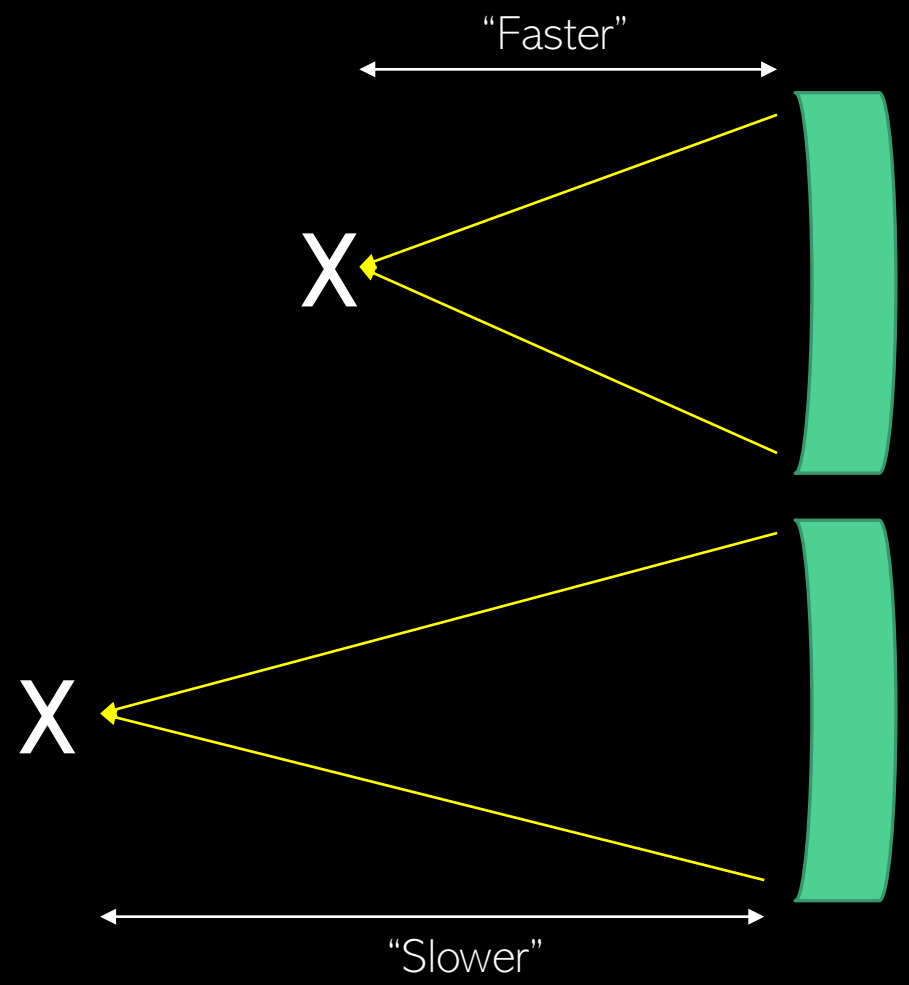
F Ratio (f/):

Basics Terminology

Aperture:
Diameter of the main optic (lens or mirror)

Focal Length:
Distance to the focus point from the main optic

F Ratio (f/):
How “fast” an optic brings light to a focus



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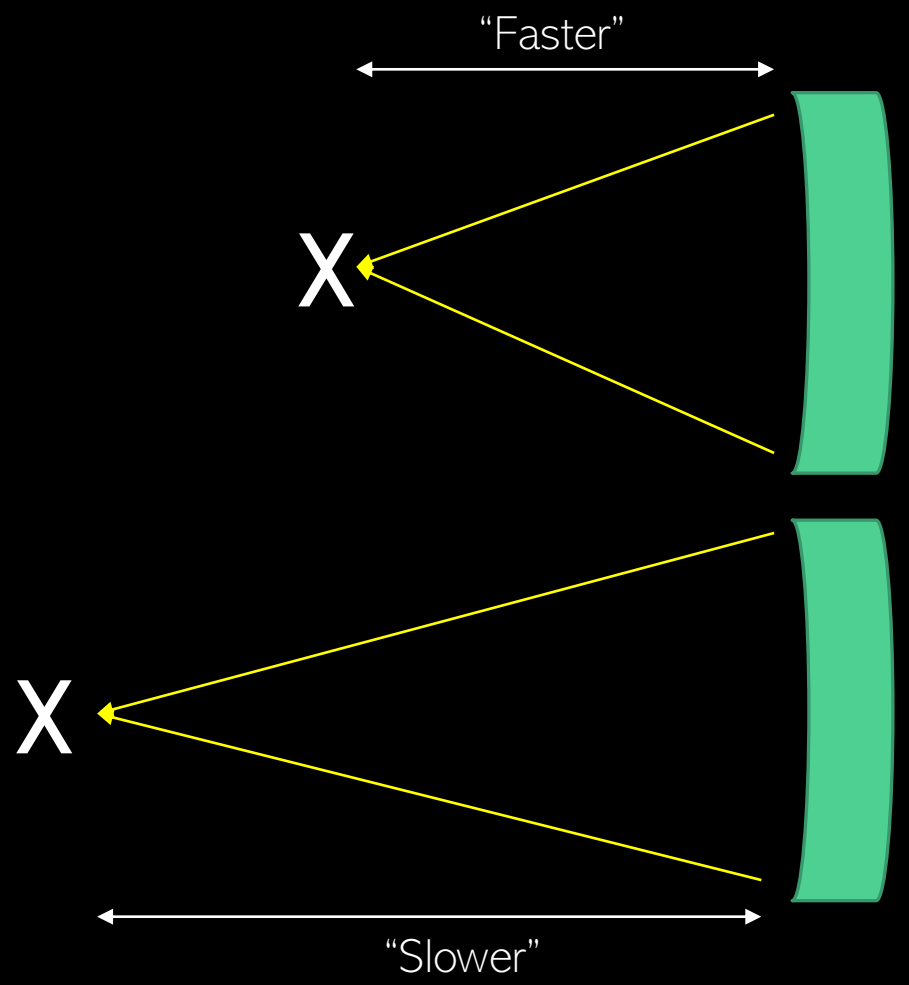
- F Ratio is the focal length divides by the aperture



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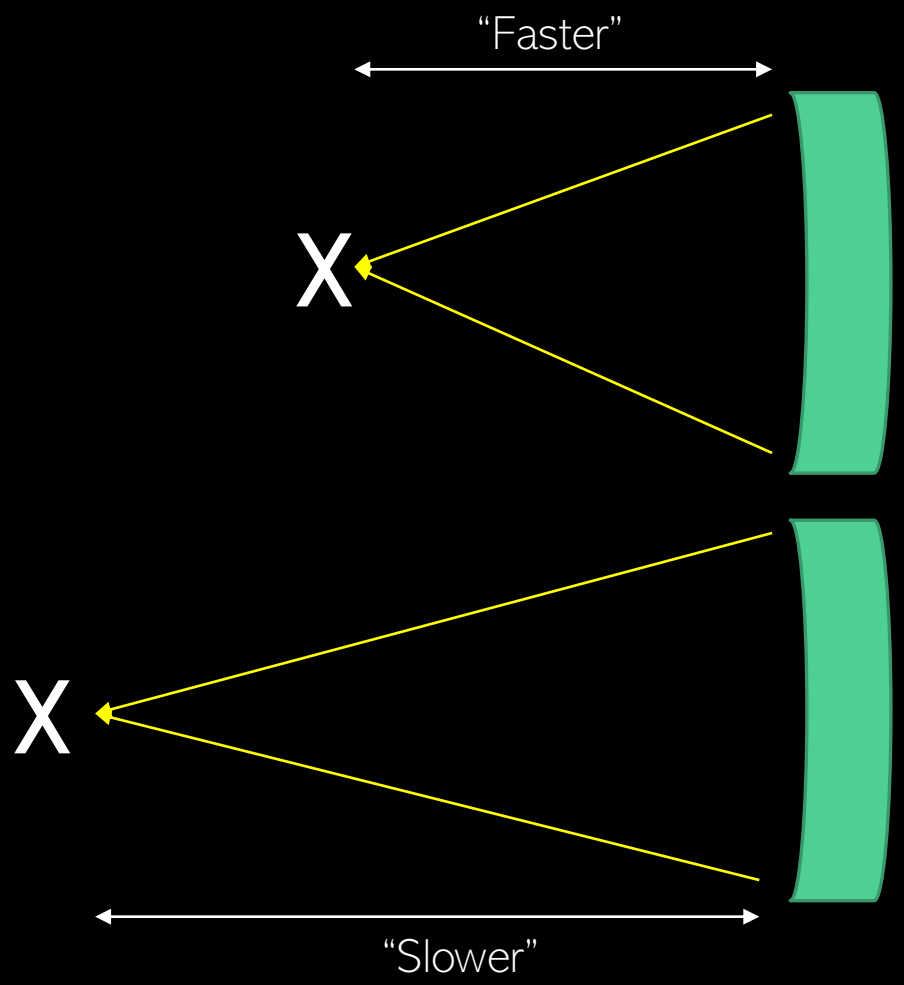
How "fast" an optic brings light to a focus

- F Ratio is the focal length divides by the aperture
- Shown as f/x on a telescope (Ex: f/4, f/7, f/10)



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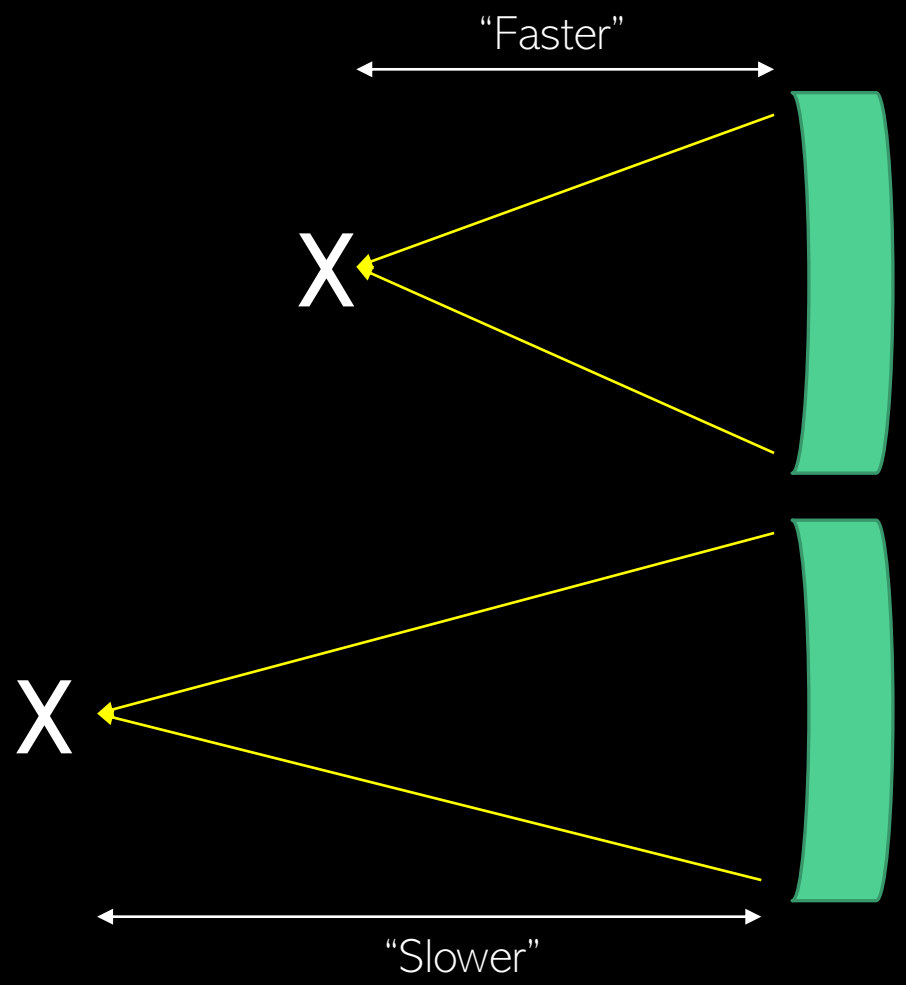

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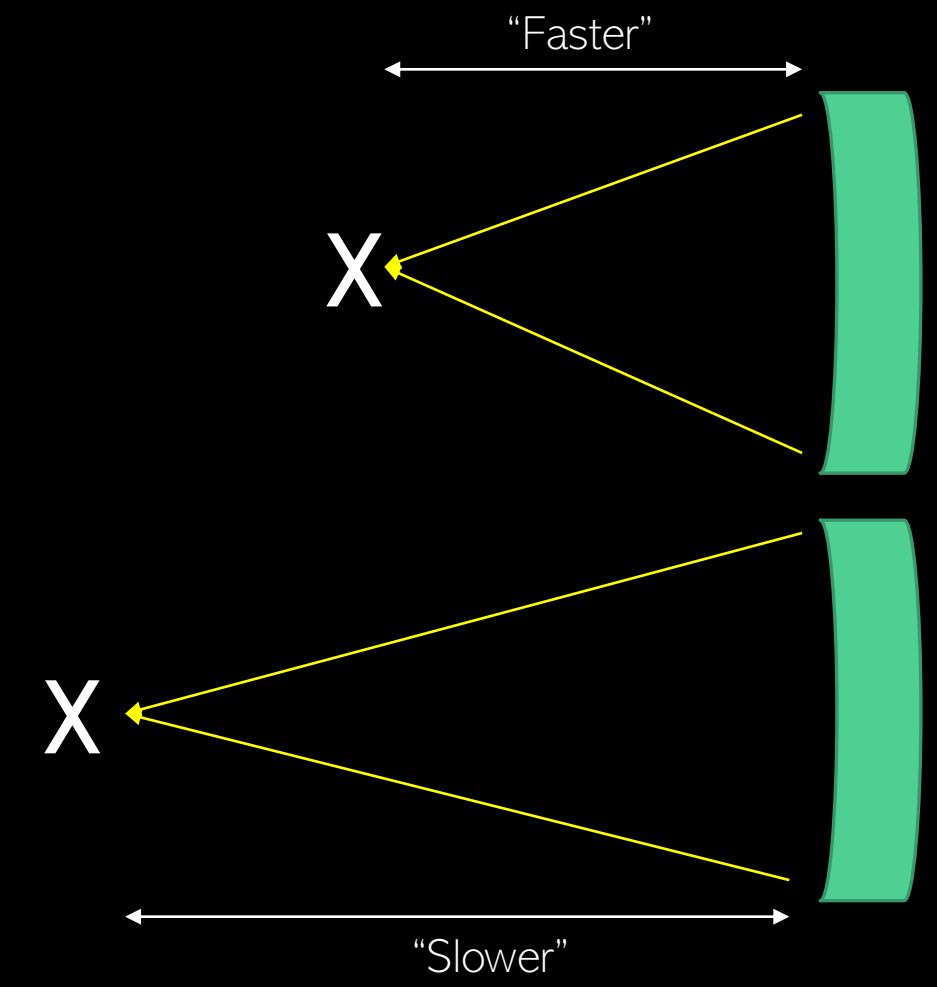
- F Ratio is the focal length divides by the aperture
- Shown as f/x on a telescope (Ex: f/4, f/7, f/10)
- Smaller the f/ ratio the "faster" the optics
- Faster optics produce images in less time (mostly for astrophotography)



Basics Terminology Overview

<u>Aperture:</u>

Diameter of the main optic (lens or mirror)

- Not as important for astrophotography purposes
- Can benefit for planetary and lunar work due to increased resolution

Bigger telescopes are not the name of the game in astrophotography

Larger telescopes can be more affected by nightly conditions

Basics Terminology Overview

Focal Length:

Distance to the focus point from the main optic

- Shorter focal lengths provided a wider field of view and a smaller image scale
- Longer optics provided narrower field of view but large image

- Nightscape Optics: 14mm to 100mm
- Deep Space Wide Field: 100mm to 600mm
- Moderate Optics: 600mm to 1500mm
- Long Focal Length: 1500mm +

As the focal length gets longer it can amplify tracking or other issues, larger mounts are needed

The conditions of the night can also affect longer focal lengths more easily

Basics Terminology Overview

F Ratio (f/):

How “fast” an optic brings light to a focus

The F Ratio is the key for astrophotography

- Smaller the f/ ratio the faster the telescope can acquire an image

A telescope that is F/4 is 3.1x faster than an F/7 telescope

- This allows your exposures to be 3x shorter or you get 3x more data in the same time

Basics Telescope Designs

Basics Telescope Designs

Refractor

Basics Telescope Designs

Refractor

Compound

Basics Telescope Designs

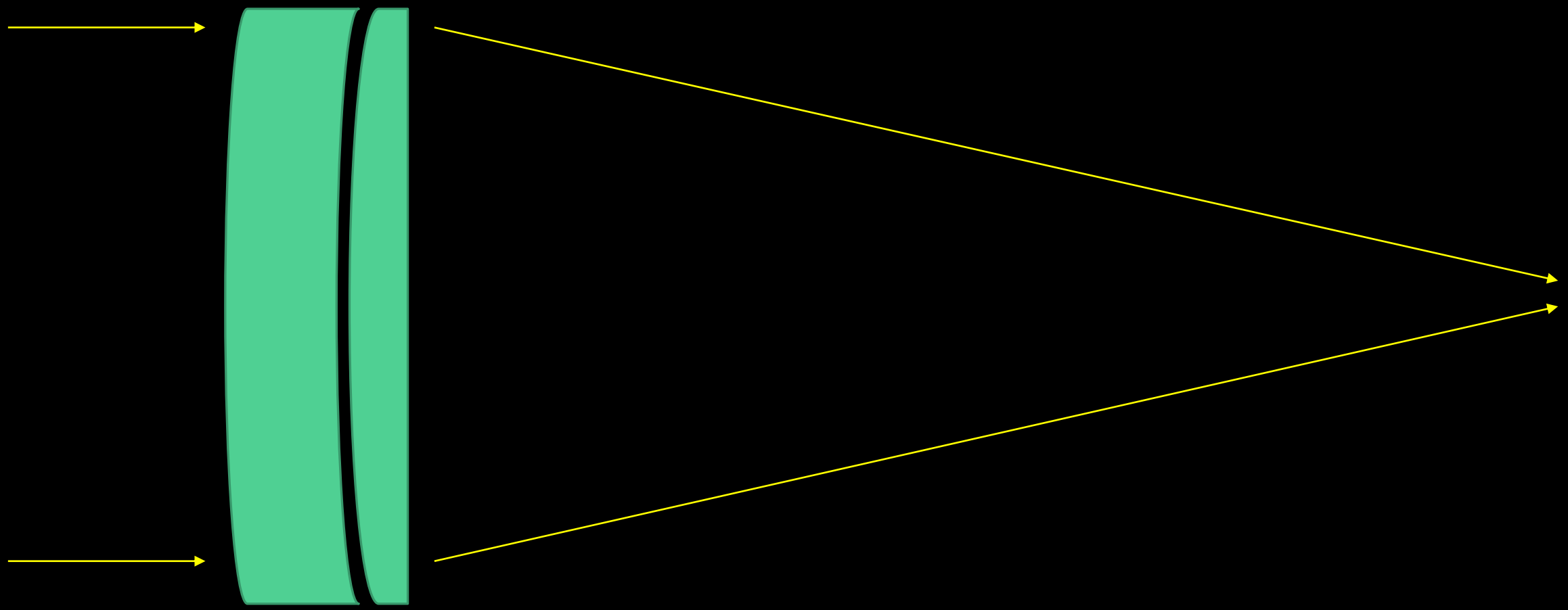
Refractor

Compound

Reflector

Refractors

Refractors



Refractors

- Lenses used to focus light to a point

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- Lenses used to focus light to a point
- Most common telescope design

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- <u>Common aperture sizes:</u>

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- <u>Common aperture sizes:</u>
  - 2.7” (50mm) to 6” (150mm)

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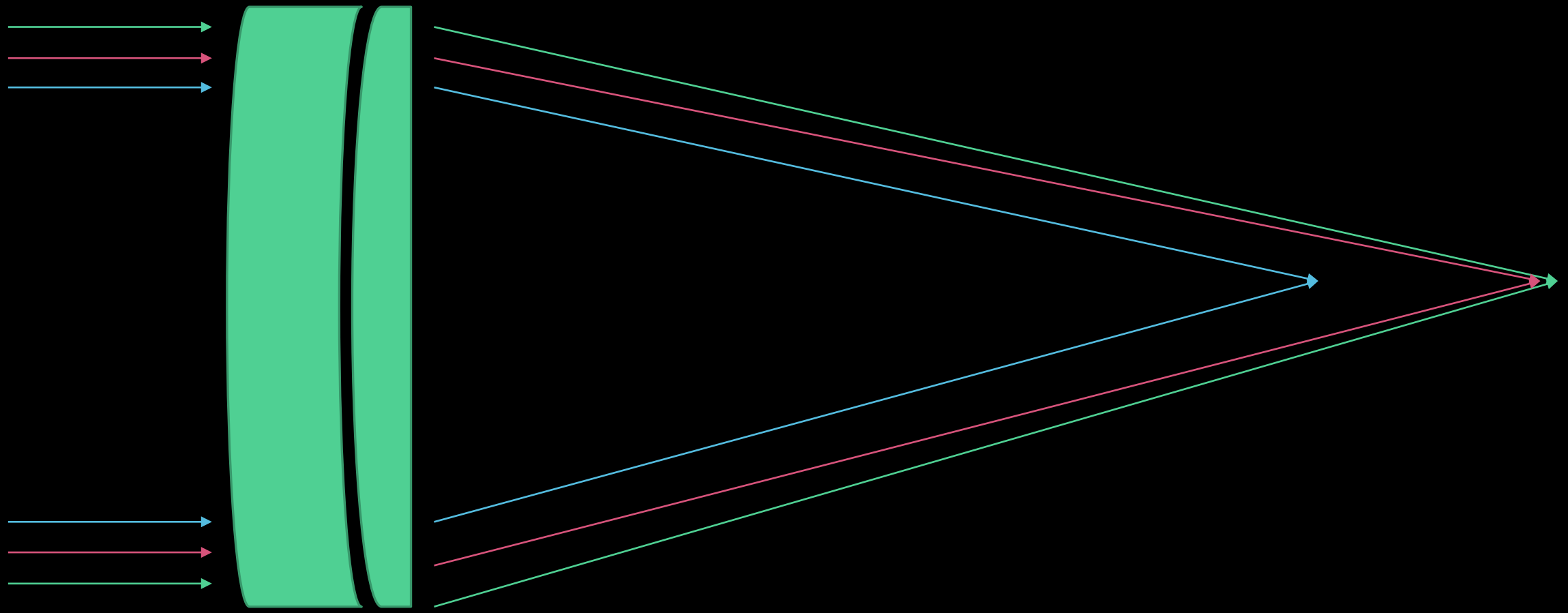
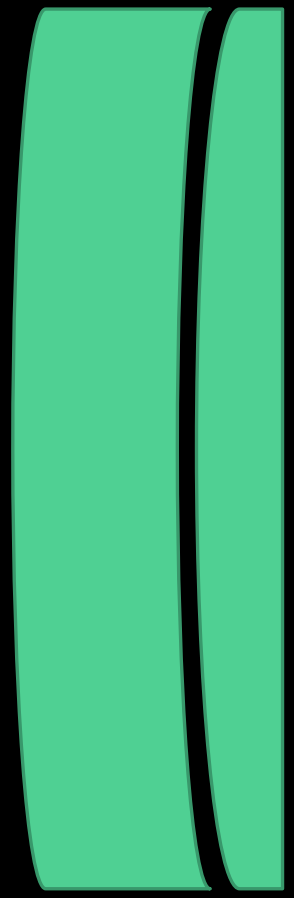
- <u>Refractor Types:</u>
  - Achromatic

Achromatic Refractors

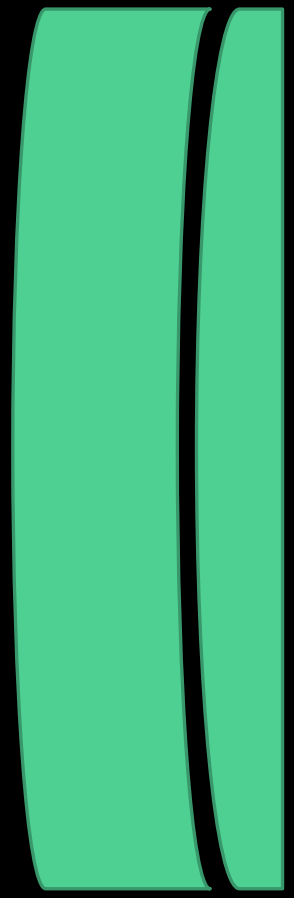


Achromatic Refractors



Composed of generally two elements

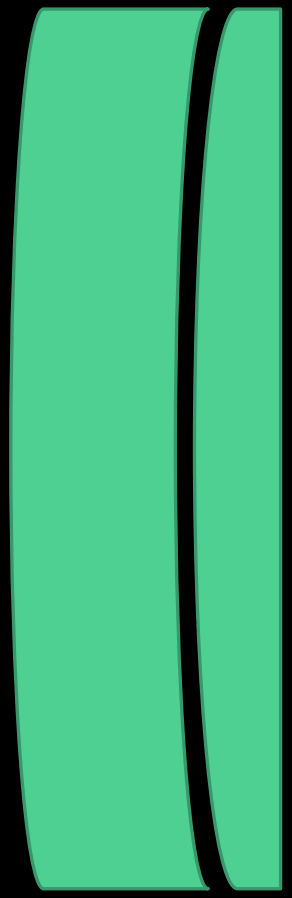
Achromatic Refractors



Composed of generally two elements

No exotic glasses used

Achromatic Refractors



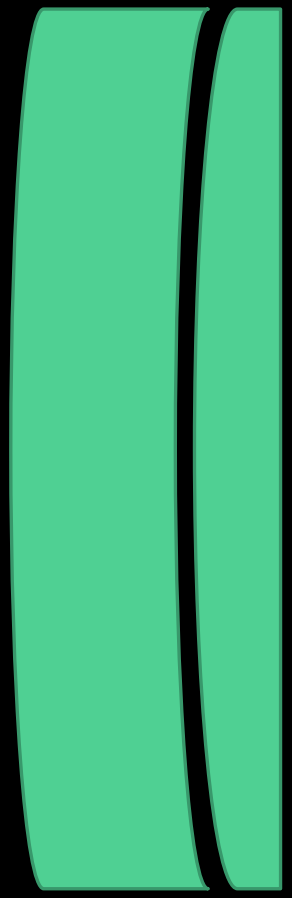
Composed of generally two elements

No exotic glasses used

Suffer from Chromatic Aberration

Not able focus all colors to the same position

Achromatic Refractors



Composed of generally two elements

No exotic glasses used

Suffer from Chromatic Aberration
    Not able focus all colors to the same position

Good for visual work, common in beginner refractors

Refractors

- Lenses used to focus light to a point
- Most common telescope design

- <u>Common aperture sizes:</u>
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  - Apochromatic

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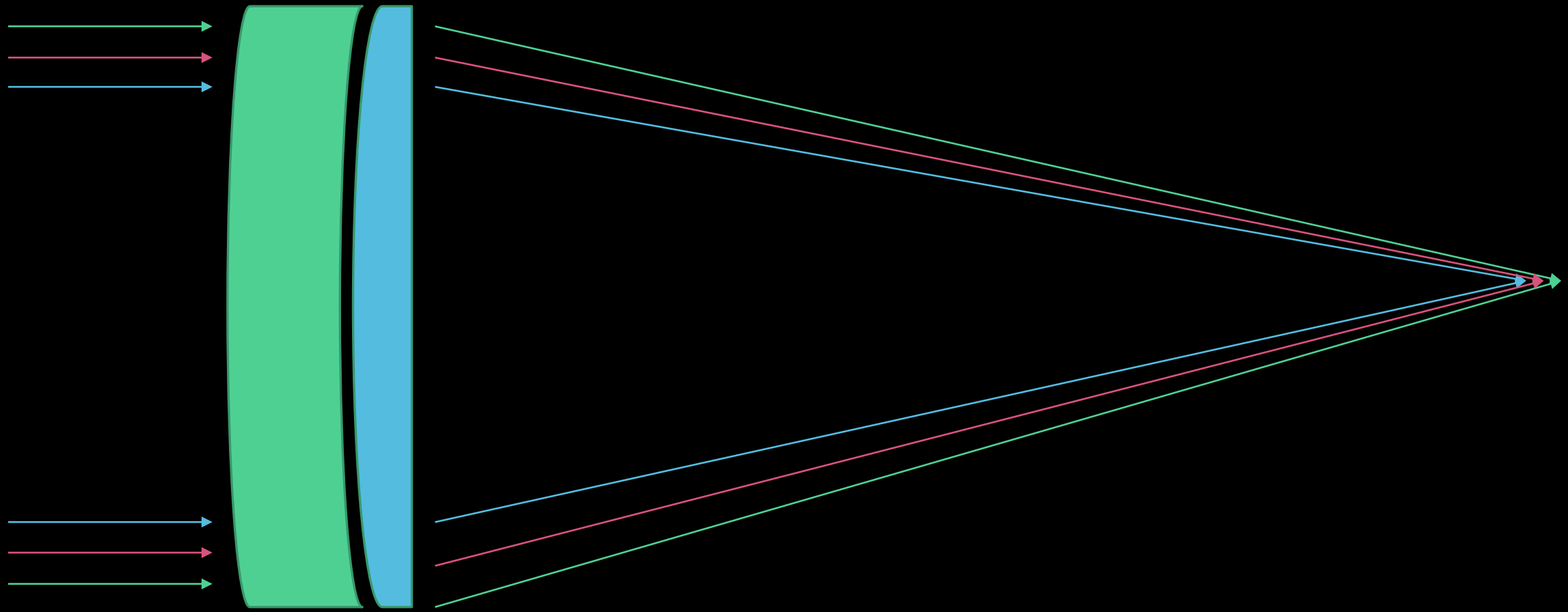
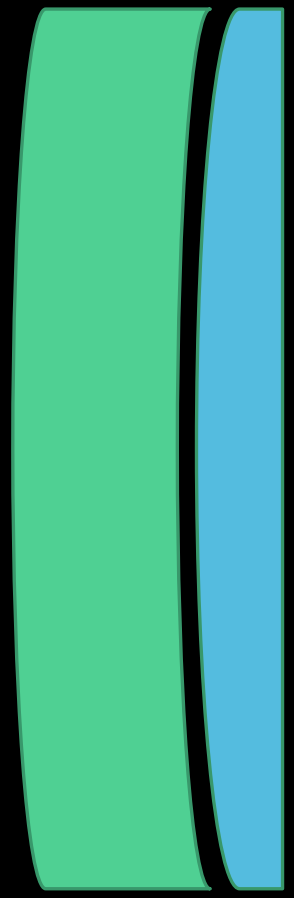
- <u>Refractor Types:</u>
  - Achromatic
  - Apochromatic
    - ED Doublet

ED Doublet Apochromatic Refractor

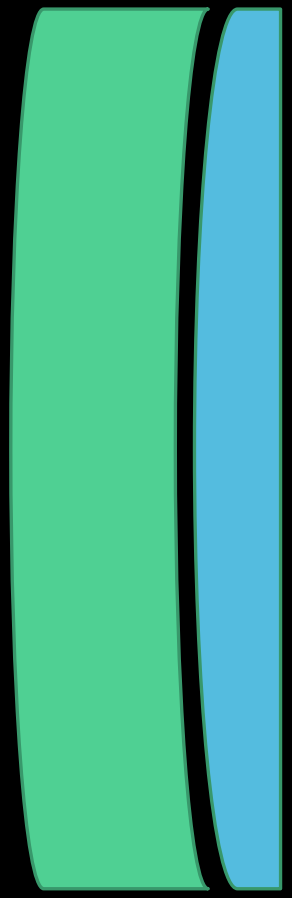


ED Doublet Apochromatic Refractor



Composed of two elements

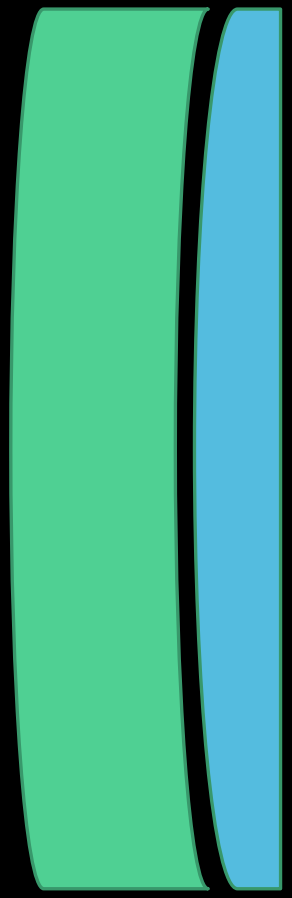
ED Doublet Apochromatic Refractor



Composed of two elements

Uses one exotic glass element known as Extra-Low Desperation glass (ED glass) or other similar glasses

ED Doublet Apochromatic Refractor



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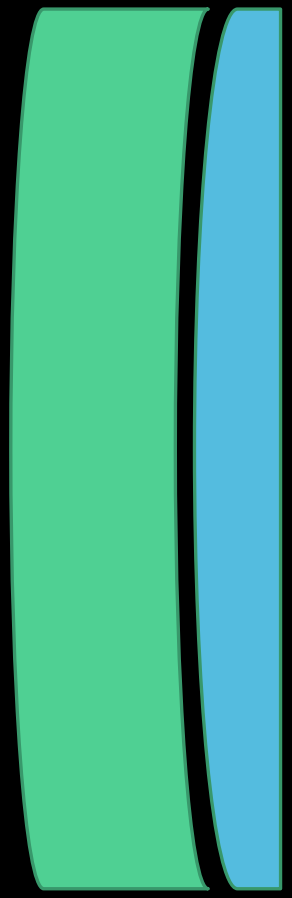
Use of ED glass aids in color correction (reduced Chromatic Aberration)

ED Doublet Apochromatic Refractor



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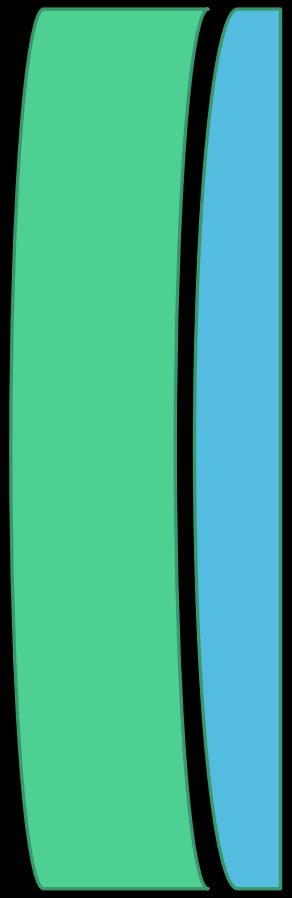
Generally, requires the focal length to be somewhat longer for good correction

ED Doublet Apochromatic Refractor



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Use of ED glass aids in color correction (reduced Chromatic Aberration)

Generally, requires the focal length to be somewhat longer for good correction

Excellent for visual work and good for astrophotography

Refractors

- Lenses used to focus light to a point
- Most common telescope design

- <u>Common aperture sizes:</u>
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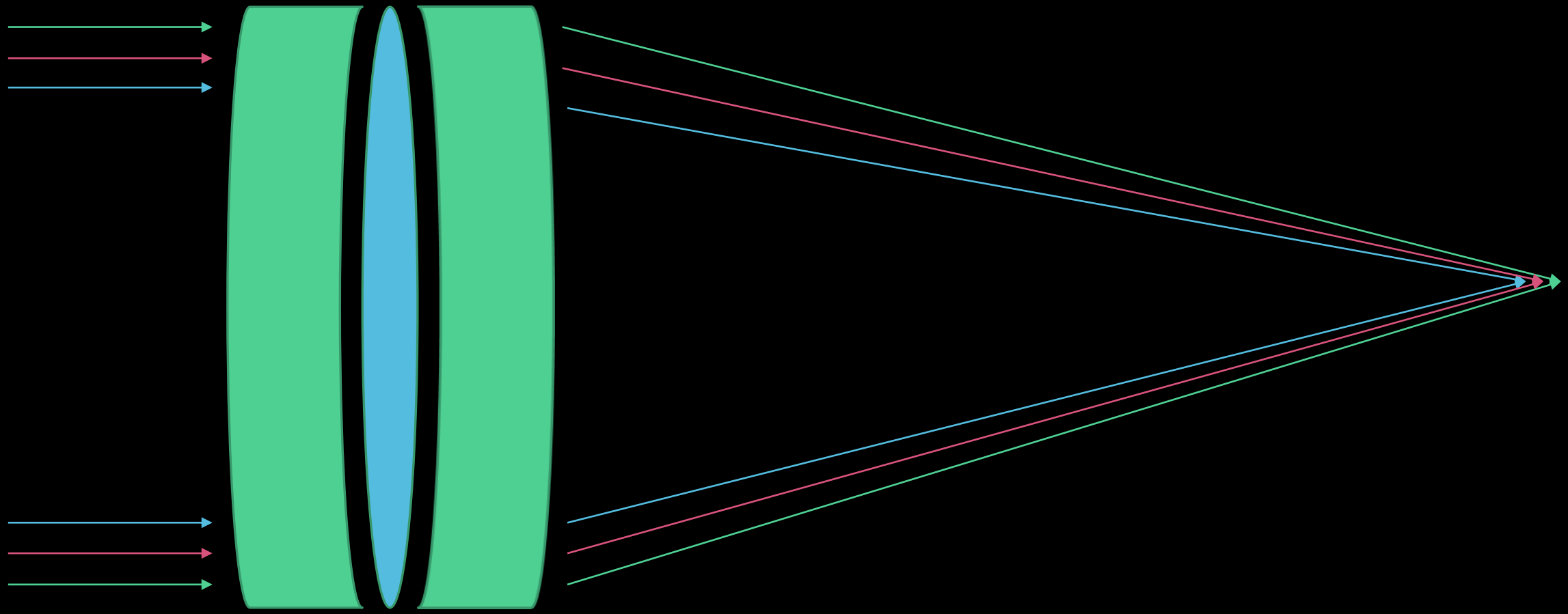
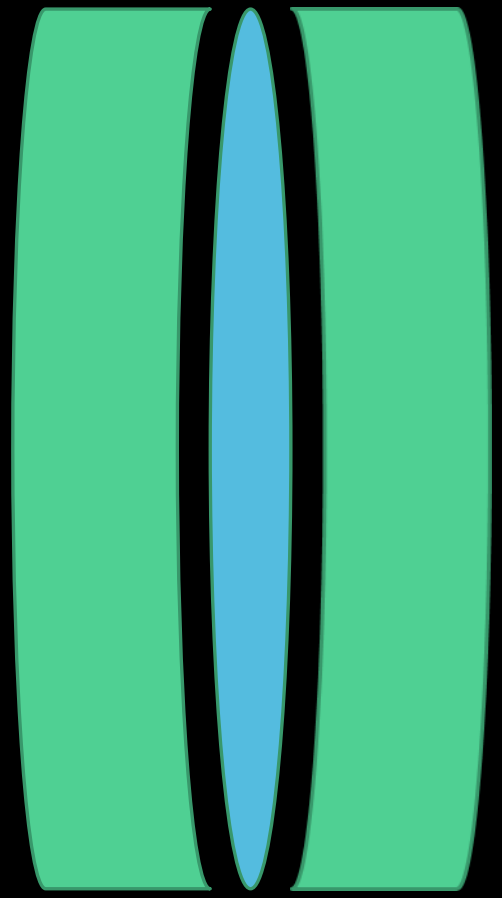
- <u>Refractor Types:</u>
  - Achromatic
  - Apochromatic
    - ED Doublet
    - ED Triplet

ED Triplet Apochromatic Refractor

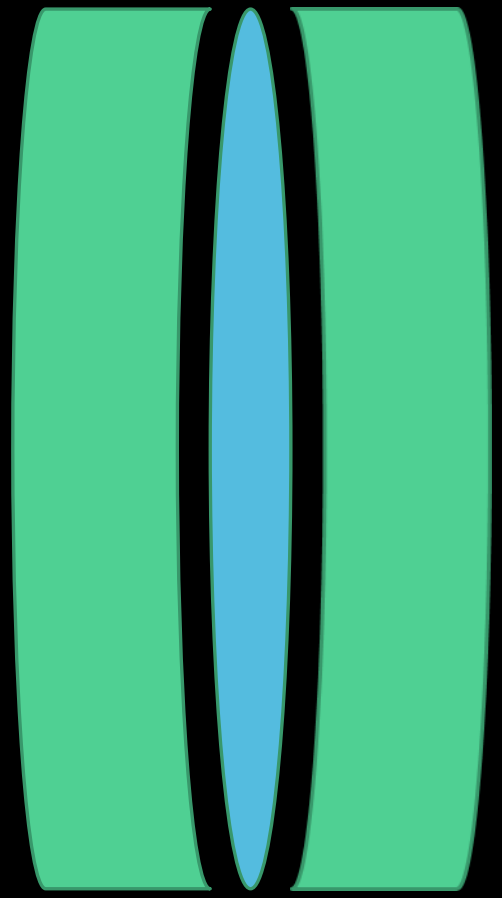


ED Triplet Apochromatic Refractor



Composed of three elements

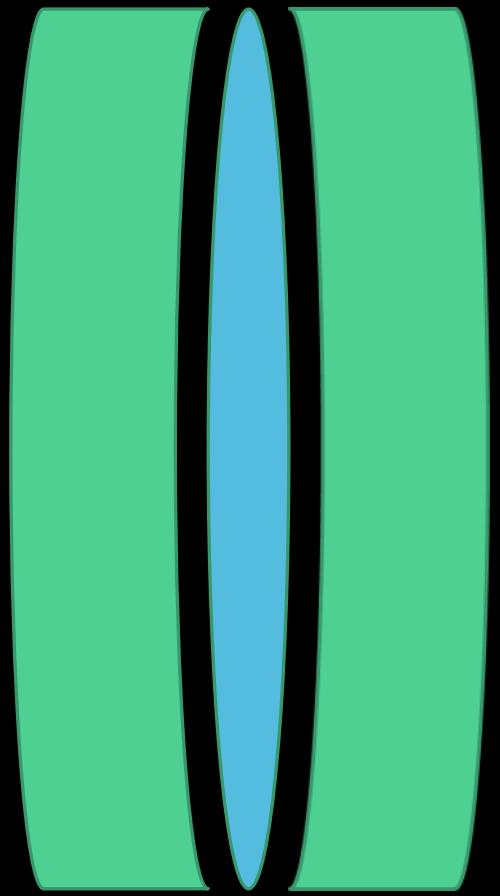
ED Triplet Apochromatic Refractor



Composed of three elements

Uses one or more ED glass element.

ED Triplet Apochromatic Refractor

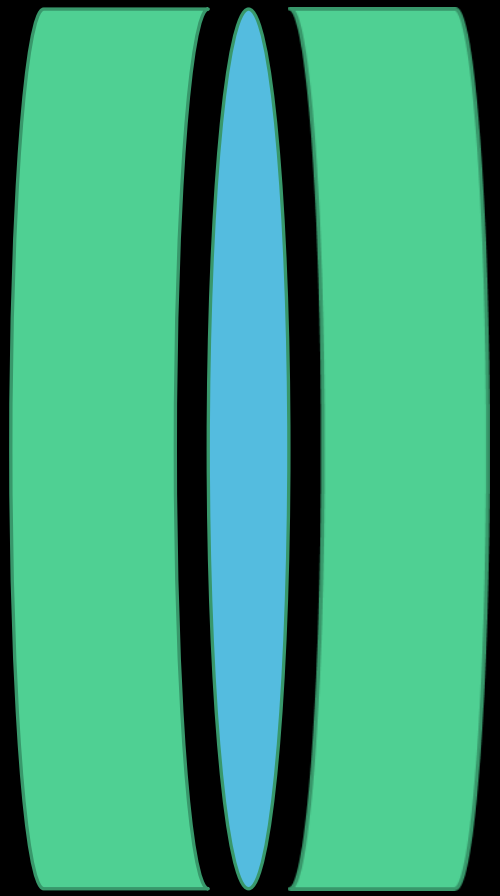


Composed of three elements

Uses one or more ED glass element.

The use of ED glass and the additional rear elements aids in color correction

ED Triplet Apochromatic Refractor



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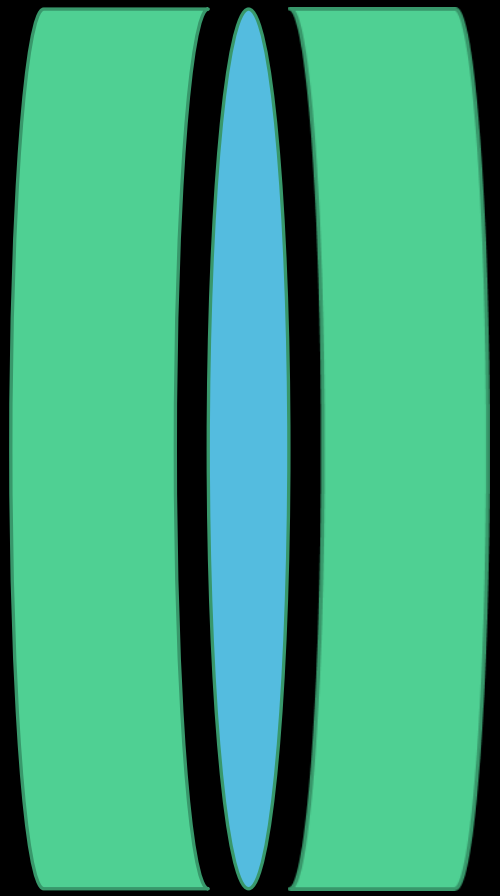
Shorter focal lengths with excellent correction can be produced

ED Triplet Apochromatic Refractor



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Excellent for visual work and astrophotography

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- Most common telescope design

- <u>Common aperture sizes:</u>
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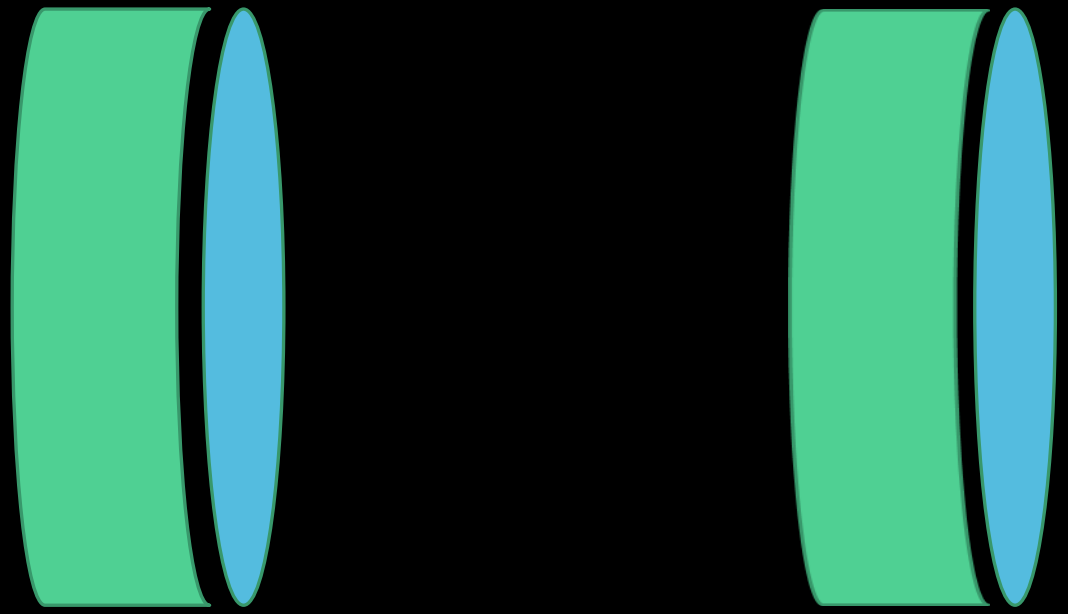
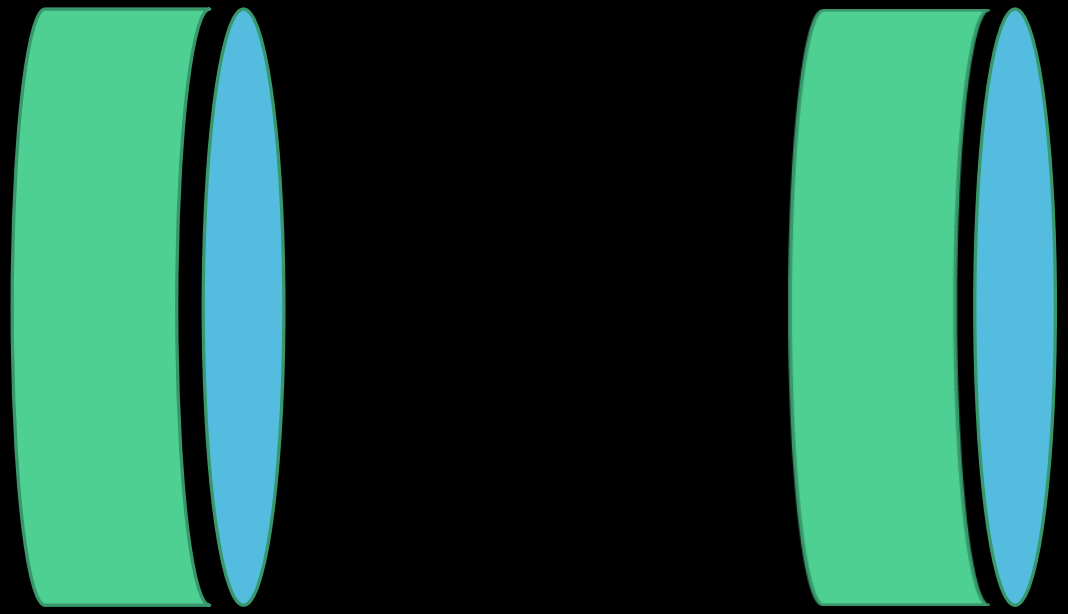
- <u>Refractor Types:</u>
  - Achromatic
  - Apochromatic
    - ED Doublet
    - ED Triplet
    - Multiple element

Multiple Element Apochromatic Refractor



Composed of three or more elements

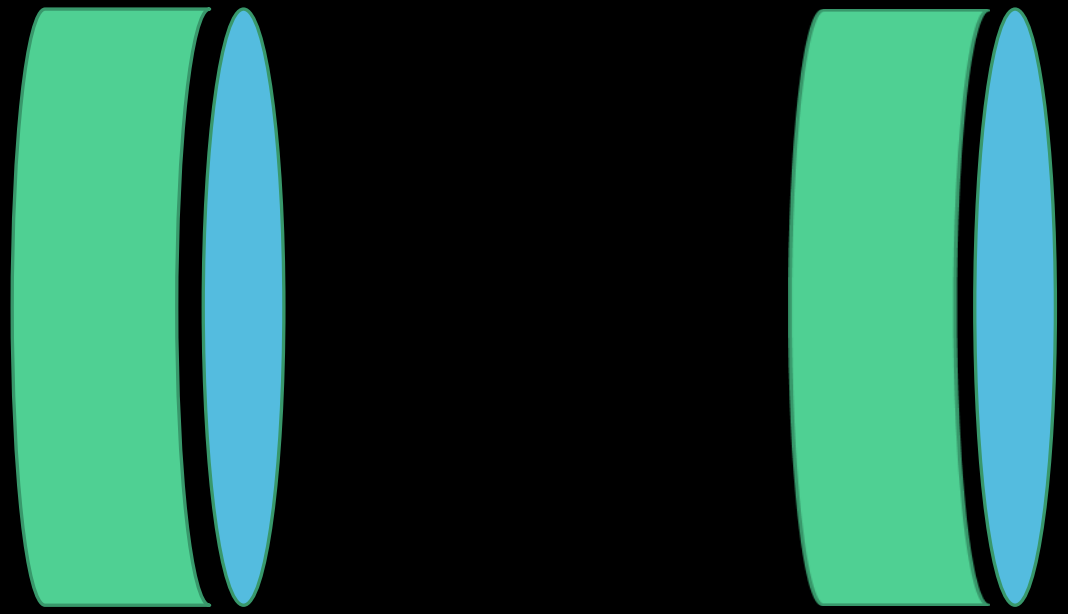
Multiple Element Apochromatic Refractor



Composed of three or more elements

Commonly referred to as a Petzval design

Multiple Element Apochromatic Refractor



Composed of three or more elements

Commonly referred to as a Petzval design

Complex, generally used for large format imaging systems

Reflectors

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- Mirrors used to focus light to a point

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  - 5” (130mm) to 16” (405mm)

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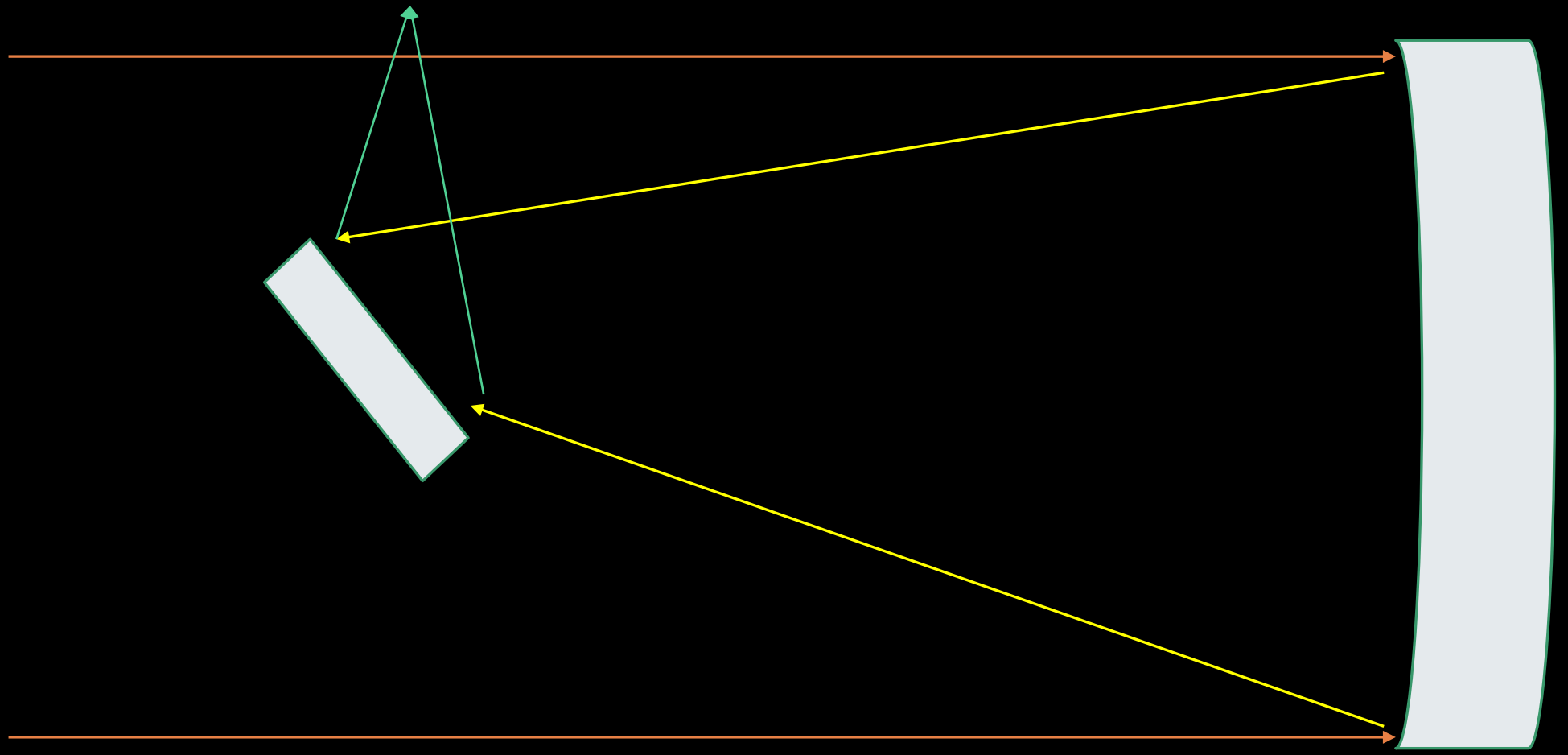
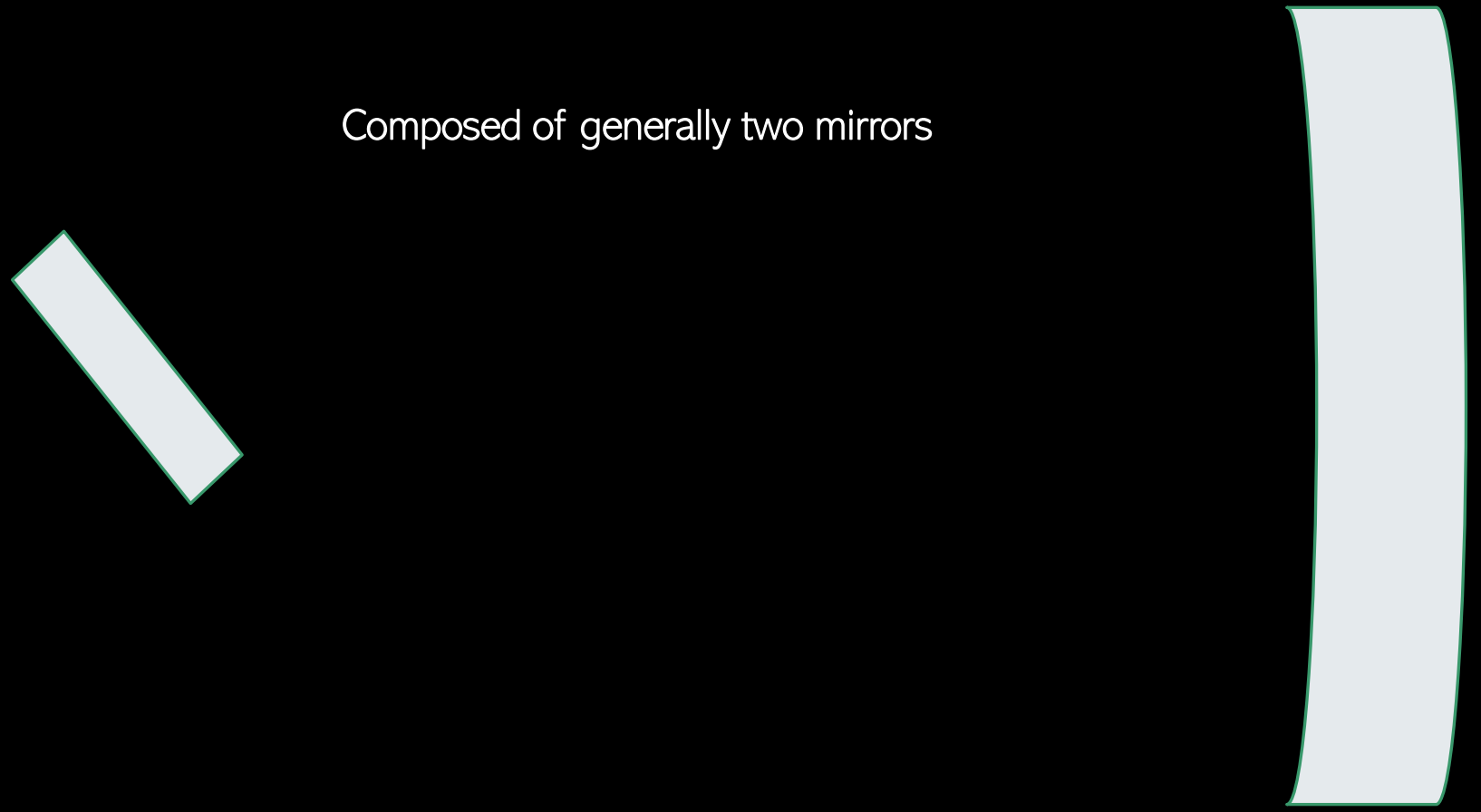
- <u>Reflector Types</u>
  - Newtonian (most common)

Newtonian Reflector Telescope



Newtonian Reflector Telescope

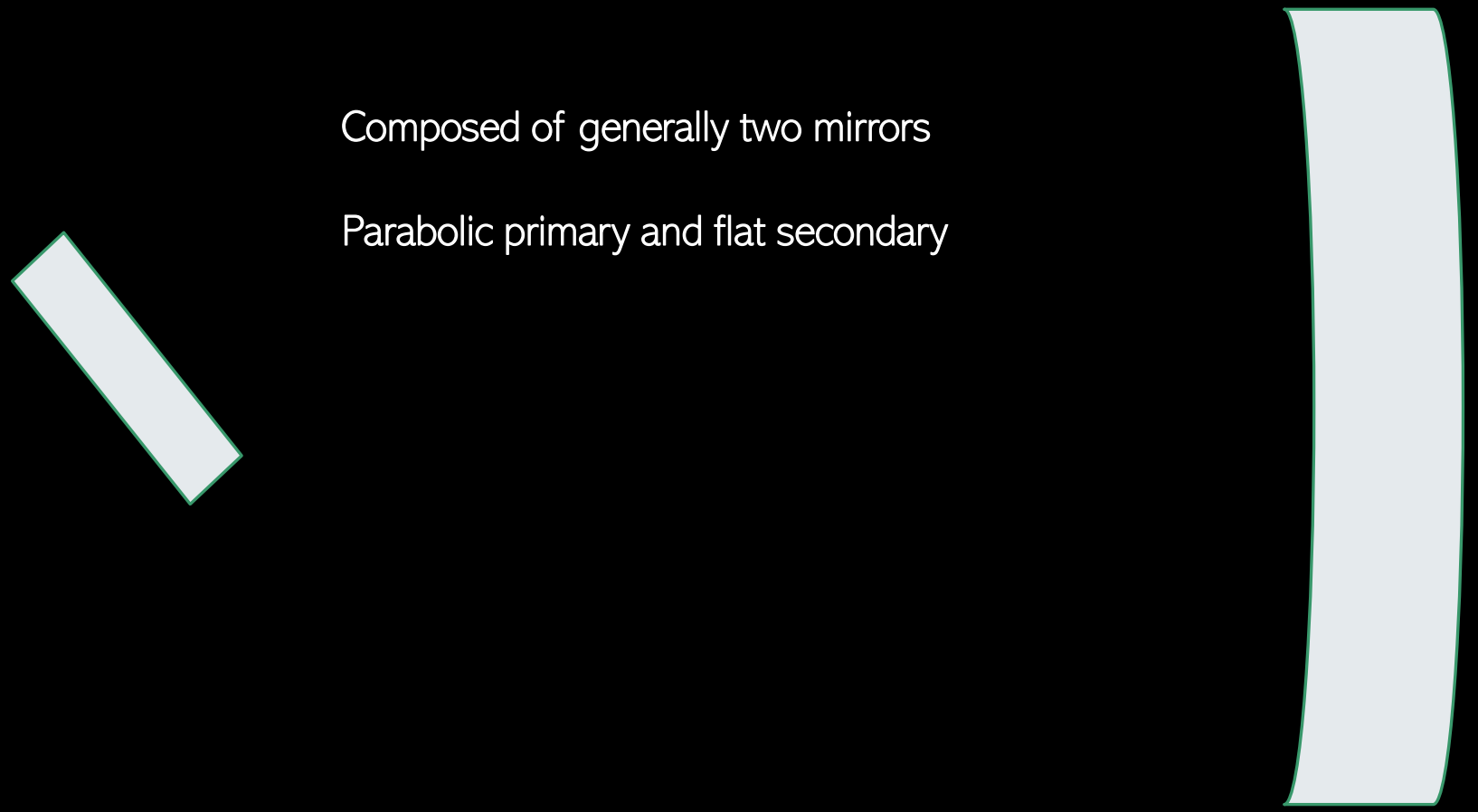
Composed of generally two mirrors



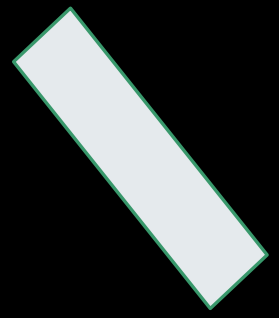
Newtonian Reflector Telescope

Composed of generally two mirrors

Parabolic primary and flat secondary



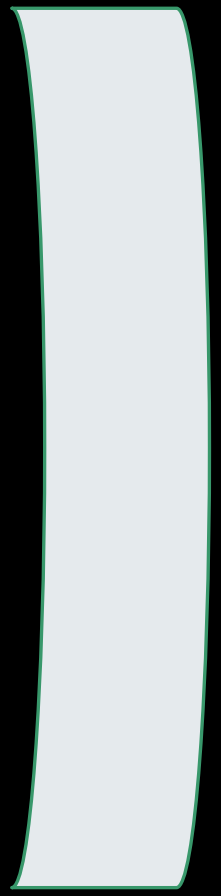
Newtonian Reflector Telescope



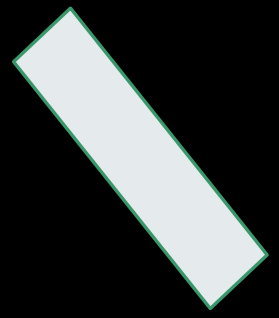
Composed of generally two mirrors

Parabolic primary and flat secondary

Suffer from coma (shorter focal lengths)
Stars at the edge of the field look like comets



Newtonian Reflector Telescope



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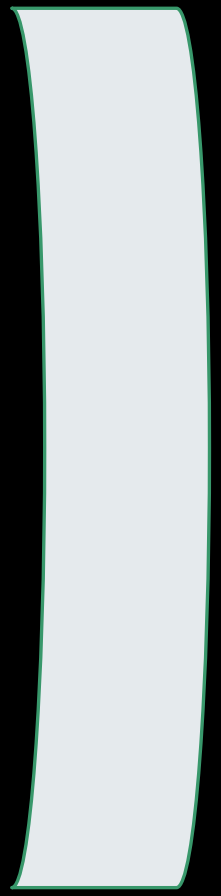
Best bang for the buck in terms of aperture



Reflector: Advantages

Physical/Mechanical

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- Can be easy to use in dobsonian format

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Optical

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- Best bang for the buck, most aperture for the least amount of money

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- Best bang for the buck, most aperture for the least amount of money
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Reflector: Advantages

Physical/Mechanical

- Can be easy to use in dobsonian format
- Smaller models can be easy to transport

Optical

- Best bang for the buck, most aperture for the least amount of money
- No Chromatic Aberration like that of a refractor
- Offer fast optics for photographic use

Reflector: Disadvantages

Physical/Mechanical

Reflector: Disadvantages

Physical/Mechanical

- Large models can be bulky

Reflector: Disadvantages

Physical/Mechanical

- Large models can be bulky
- Require collimation during each set

Reflector: Disadvantages

Physical/Mechanical

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Optics

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Optics

- Large optics can be more expensive

Reflector: Disadvantages

Physical/Mechanical

- Large models can be bulky
- Require collimation during each set
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Optics

- Large optics can be more expensive
- Images are mirror flipped, not good for terrestrial viewing

Reflector: Disadvantages

Physical/Mechanical

- Large models can be bulky
- Require collimation during each set
- Can be harder to transport

Optics

- Large optics can be more expensive
- Images are mirror flipped, not good for terrestrial viewing
- Faster optics can show coma at the edge of the field (can be corrected by coma corrector).

Compound & Cassegrains

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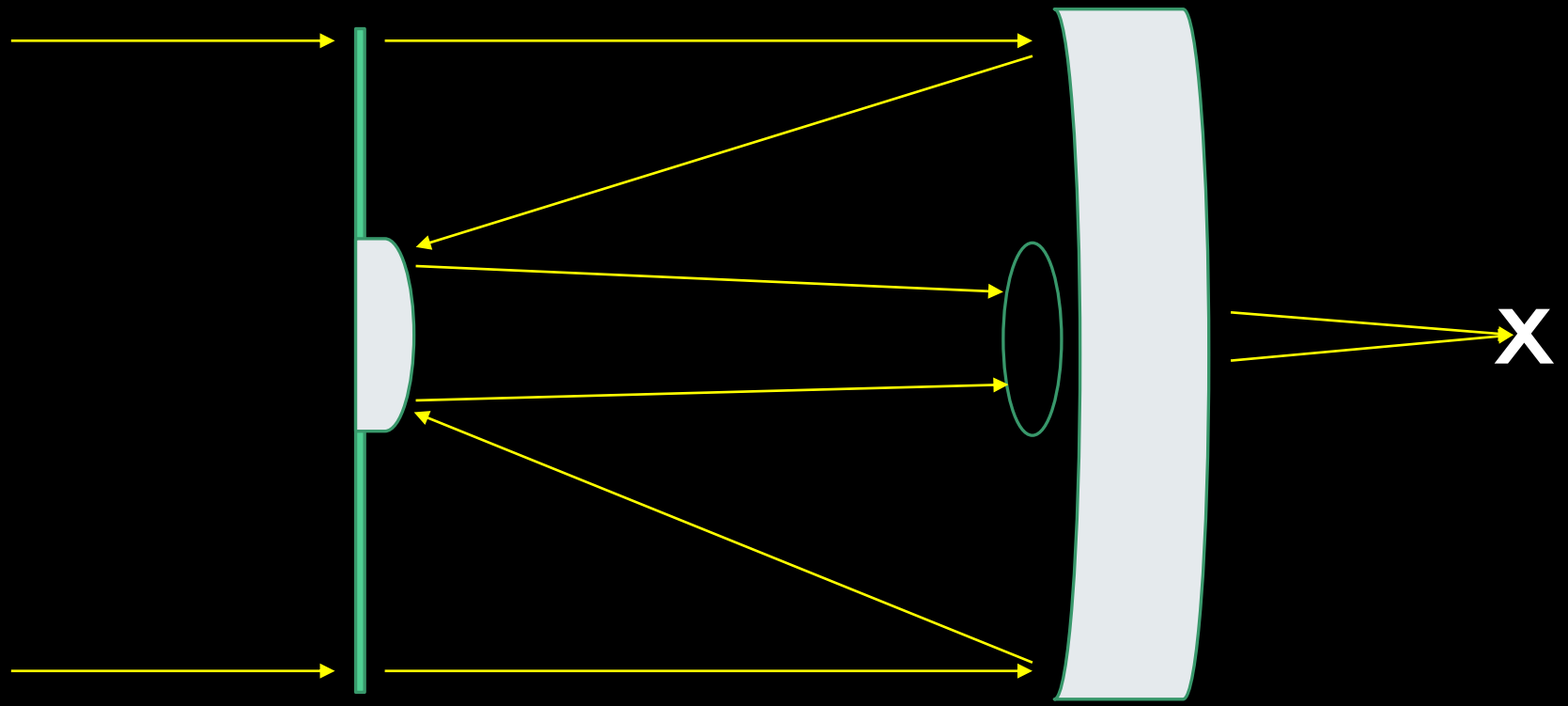
<u>Compound Designs</u>

- Schmidt-Cassegrain

Compound (Schmidt-Cassegrain)

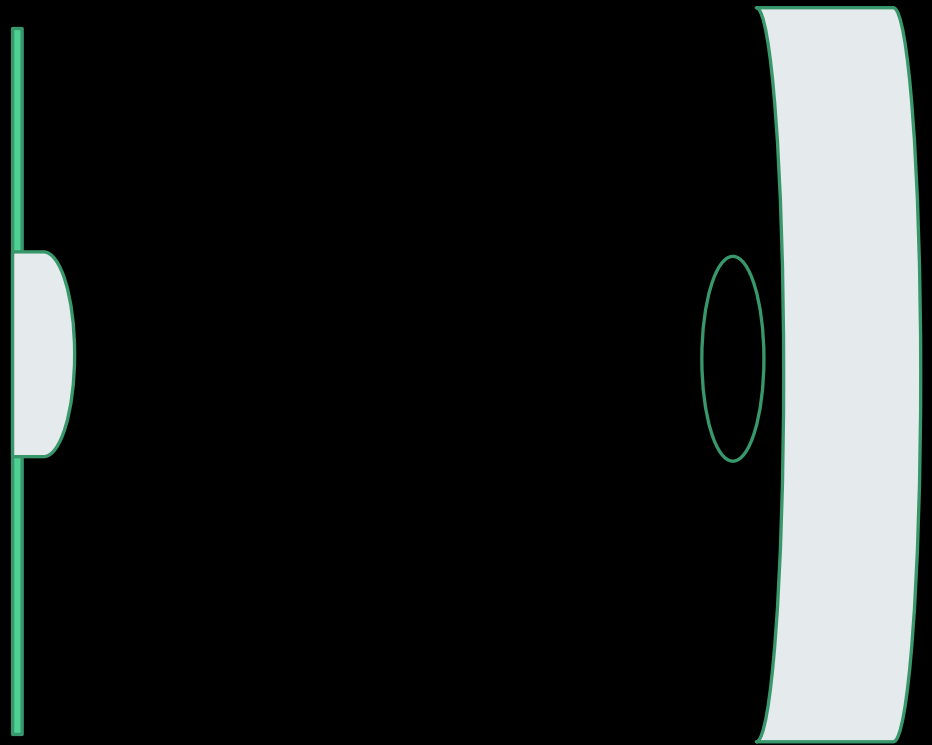


Corrector: Schmidt Corrector

Primary: Spherical mirror

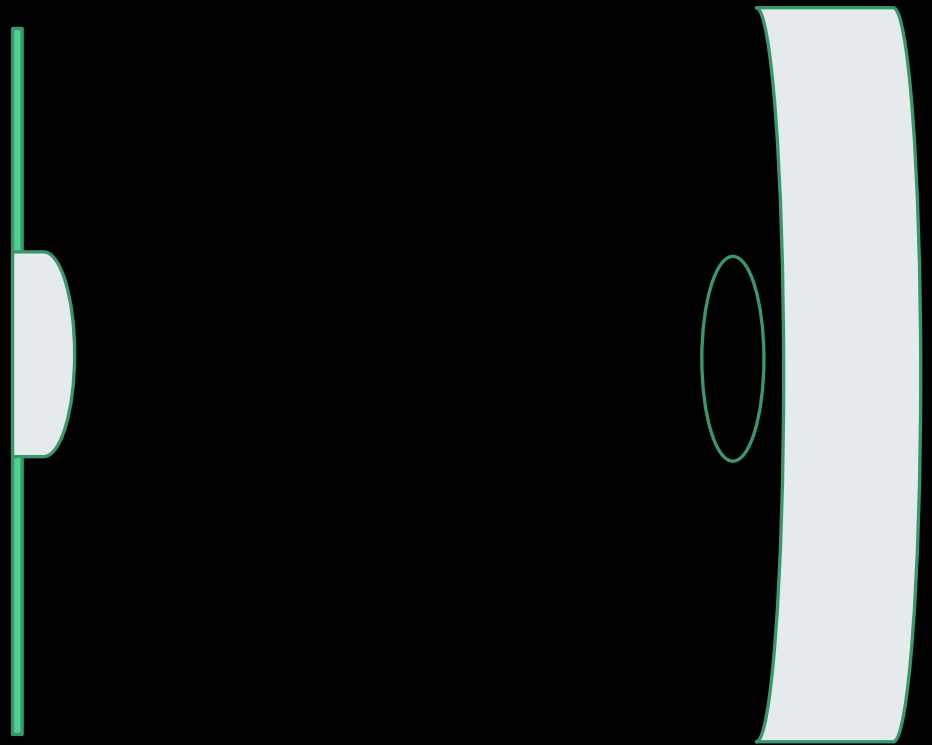
Secondary: Spherical mirror

Compound (Schmidt-Cassegrain)



Composed of a corrector in the front followed by a primary and secondary focusing light through the center of the primary mirror.

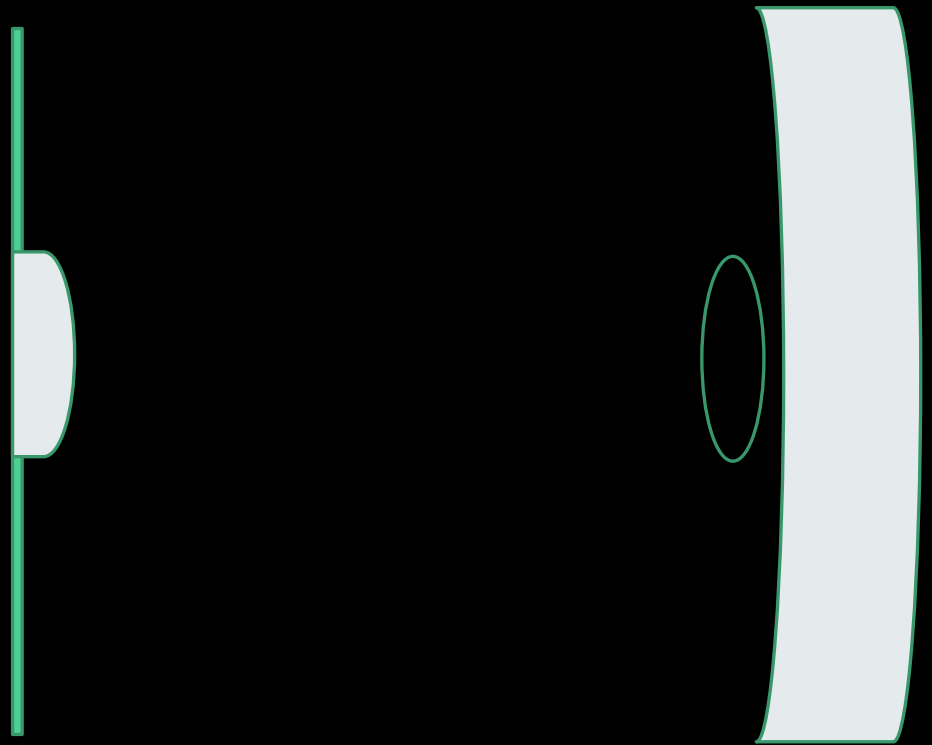
Compound (Schmidt-Cassegrain)



Composed of a corrector in the front followed by a primary and secondary focusing light through the center of the primary mirror.

Generally well corrector but can suffer from Coma

Compound (Schmidt-Cassegrain)



Composed of a corrector in the front followed by a primary and secondary focusing light through the center of the primary mirror.

Generally well corrector but can suffer from Coma

Available in 5” (127mm) to 16” (405mm) aperture sizes.

Compound & Cassegrains

- Mirrors are primarily used but designs can also incorporate lenses.
- Can come in a wide range of designs for various applications.

<u>Common Aperture Sizes</u>

- 3.5” (90mm) to 16” (405mm)
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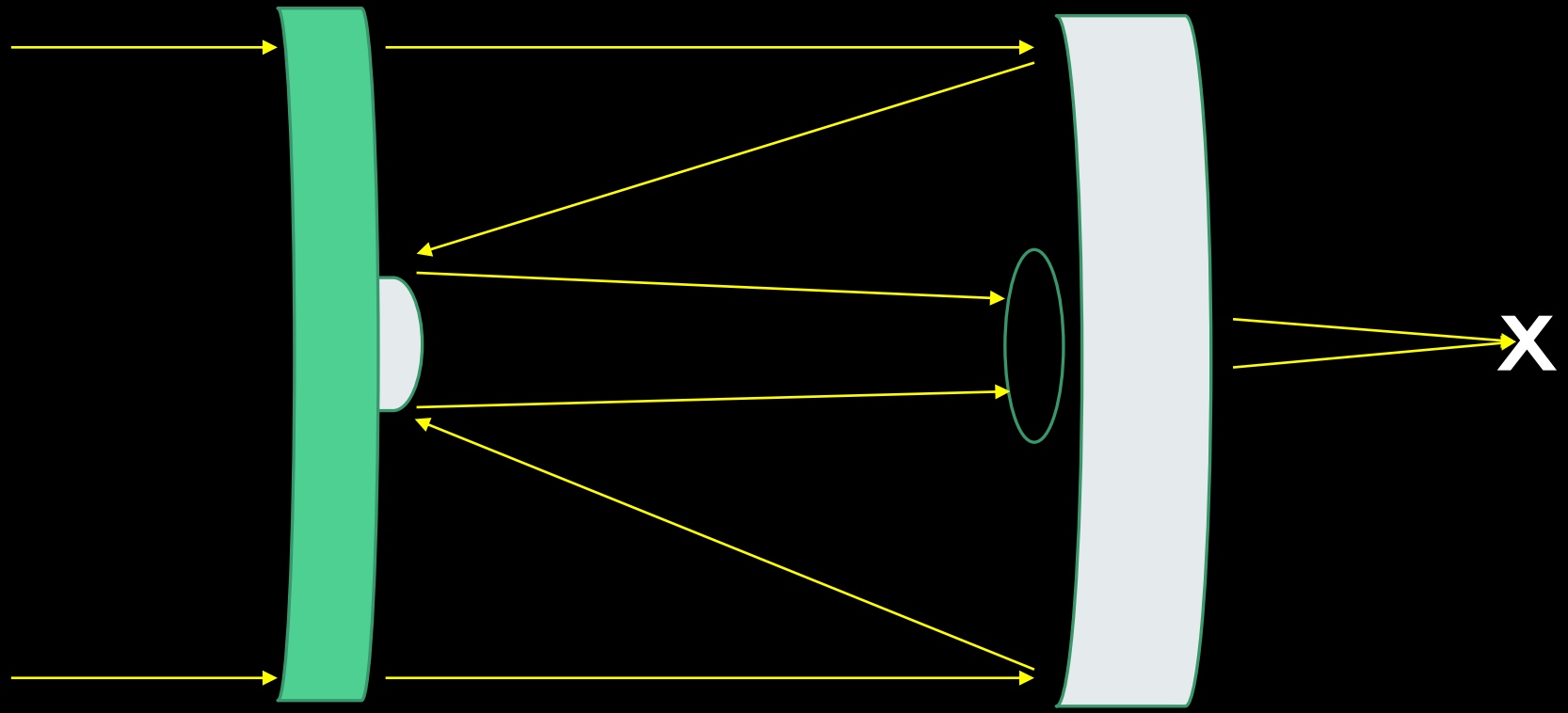
<u>Compound Designs</u>

- Schmidt-Cassegrain
- Maksutov-Cassegrain

Compound (Maksutov-Cassegrain)

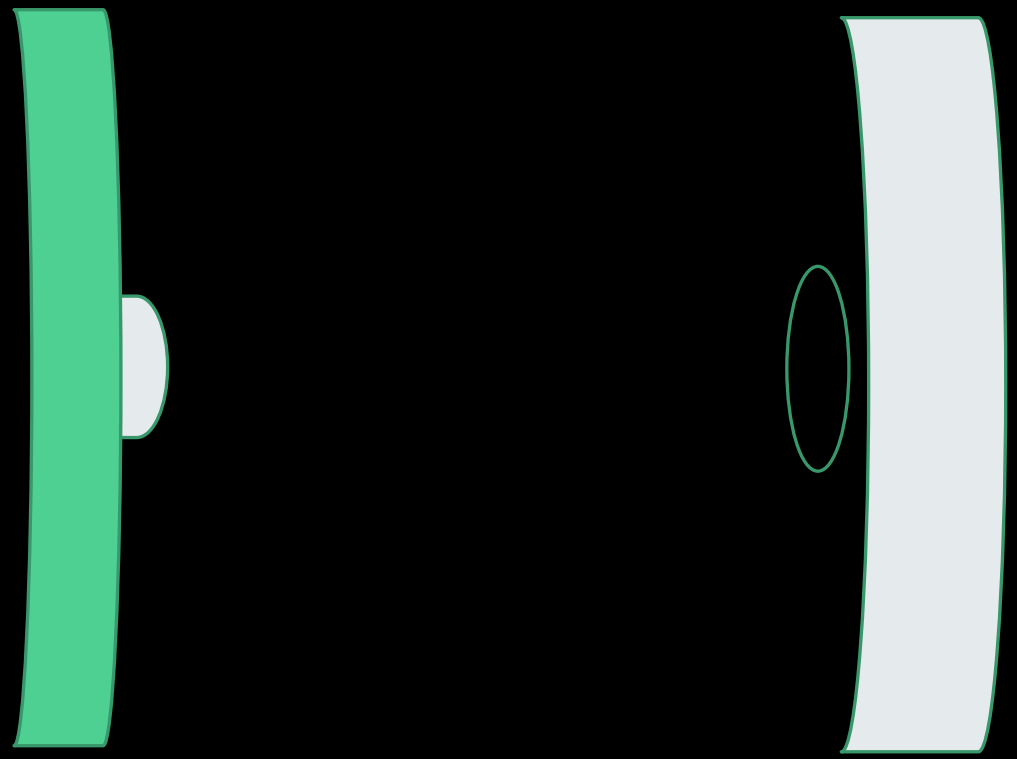


Corrector: Maksutov Corrector

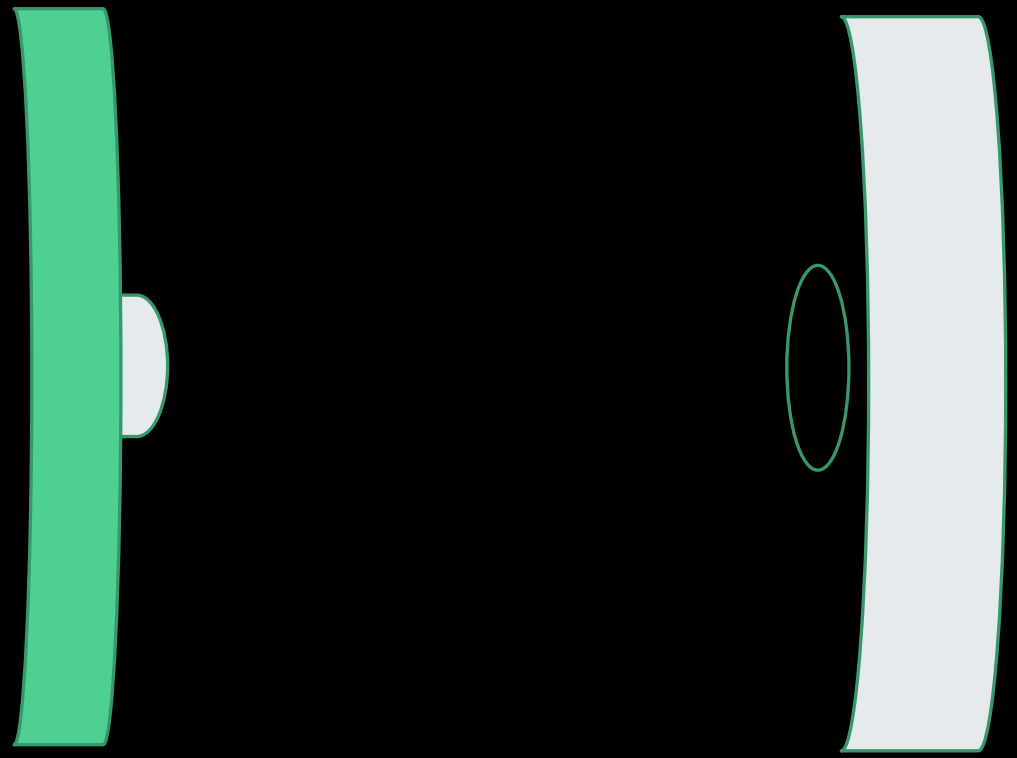
Primary: Spherical mirror

Secondary: Spherical mirror

Compound (Maksutov-Cassegrain)

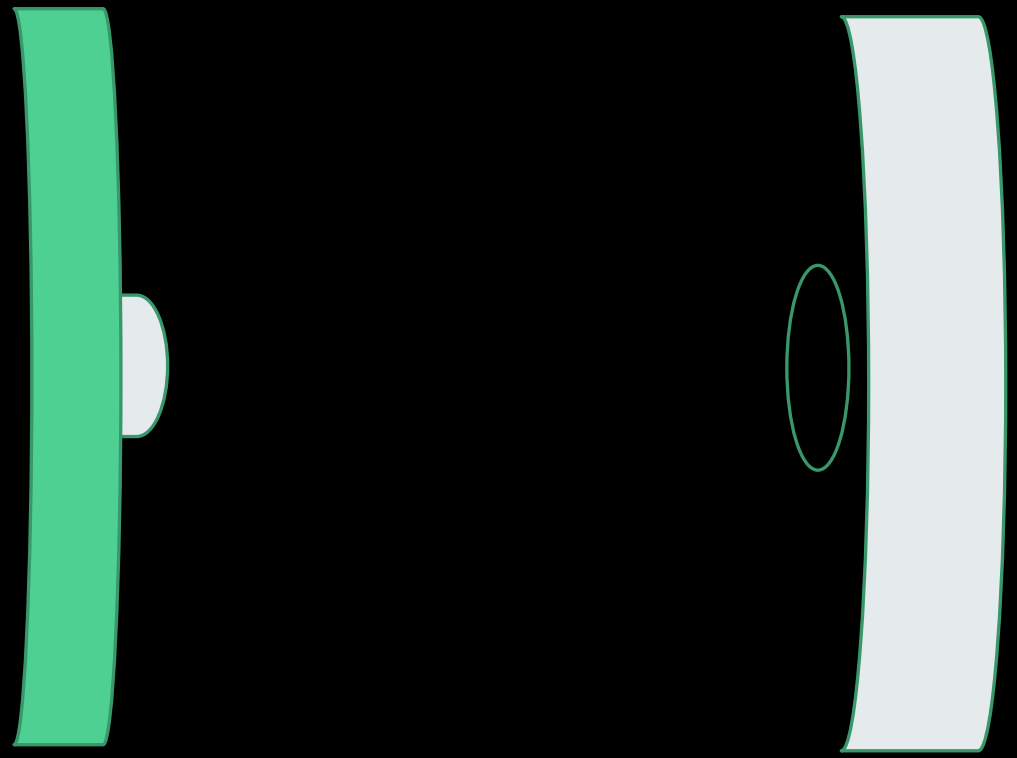


Compound (Maksutov-Cassegrain)



Composed of a meniscus corrector in the front followed by a primary and secondary focusing light through the center of the primary mirror.

Compound (Maksutov-Cassegrain)



Composed of a meniscus corrector in the front followed by a primary and secondary focusing light through the center of the primary mirror.

Generally well corrector and high contrast due to the smaller secondary mirror (compared to a Schmidt-Cassegrain)

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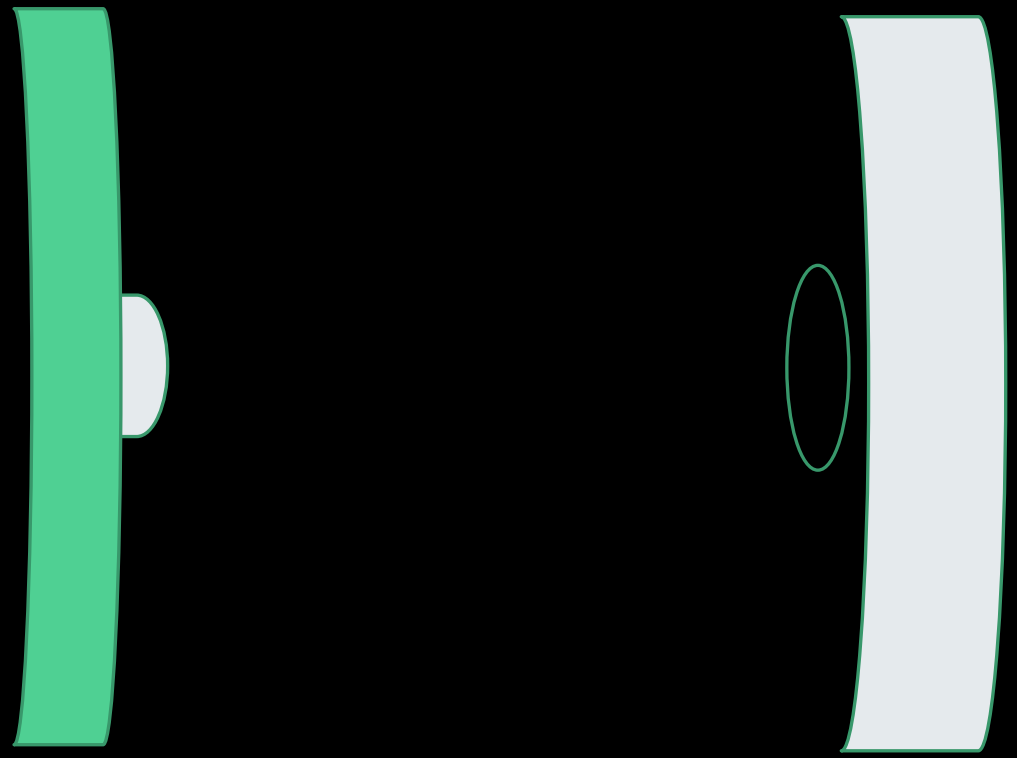


Composed of a meniscus corrector in the front followed by a primary and secondary focusing light through the center of the primary mirror.

Generally well corrector and high contrast due to the smaller secondary mirror (compared to a Schmidt-Cassegrain)

Available in 3.5” (90mm) to 7” (180mm) aperture sizes. Can be custom made up to 20” (0.5-meter).

Compound & Cassegrains

- Mirrors are primarily used but designs can also incorporate lenses.
- Can come in a wide range of designs for various applications.

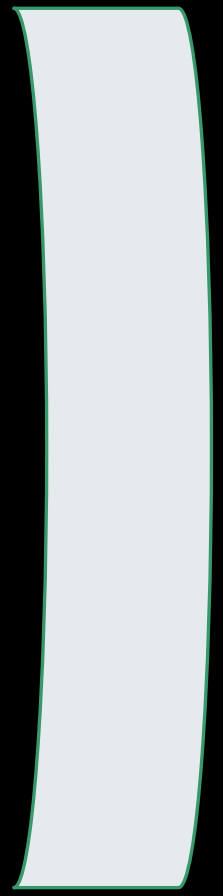
Common Aperture Sizes

- 3.5” (90mm) to 16” (405mm)
- Sizes vary on design

Compound Designs

- Schmidt-Cassegrain
- Maksutov-Cassegrain
- Other

Compound (Maksutov-Newtonian)



Corrector: Maksutov corrector

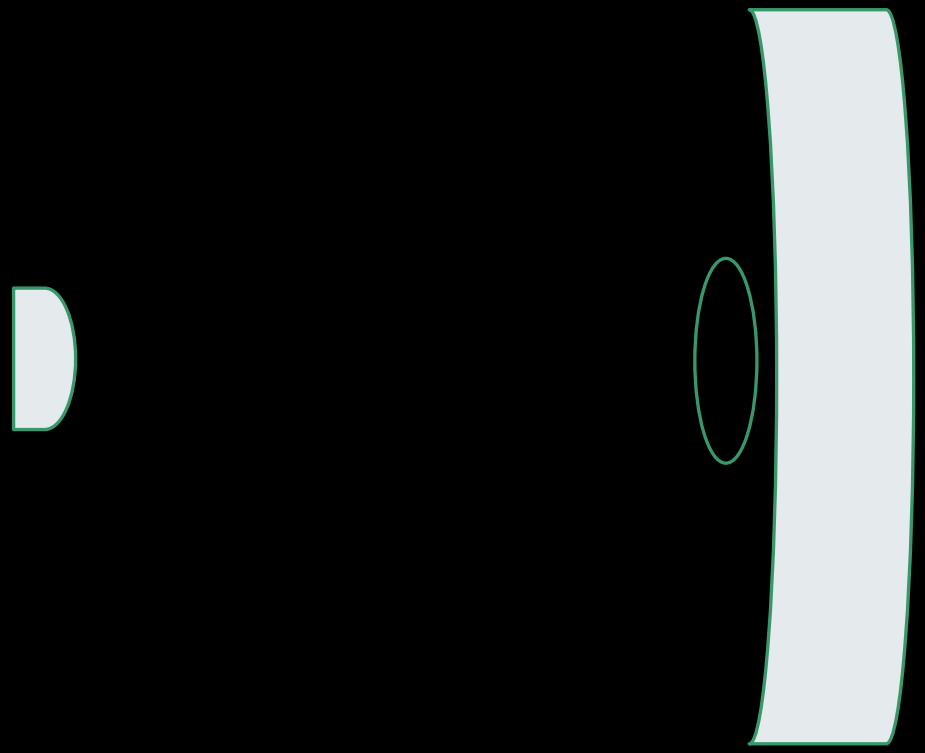
Primary: Spherical mirror

Secondary: Flat mirror

Excellent for planets and lunar (long focal length models).

Shorter focal length models are perfect for imaging due to their ability to correct the field of view natively.

Compound (Classical-Cassegrain)

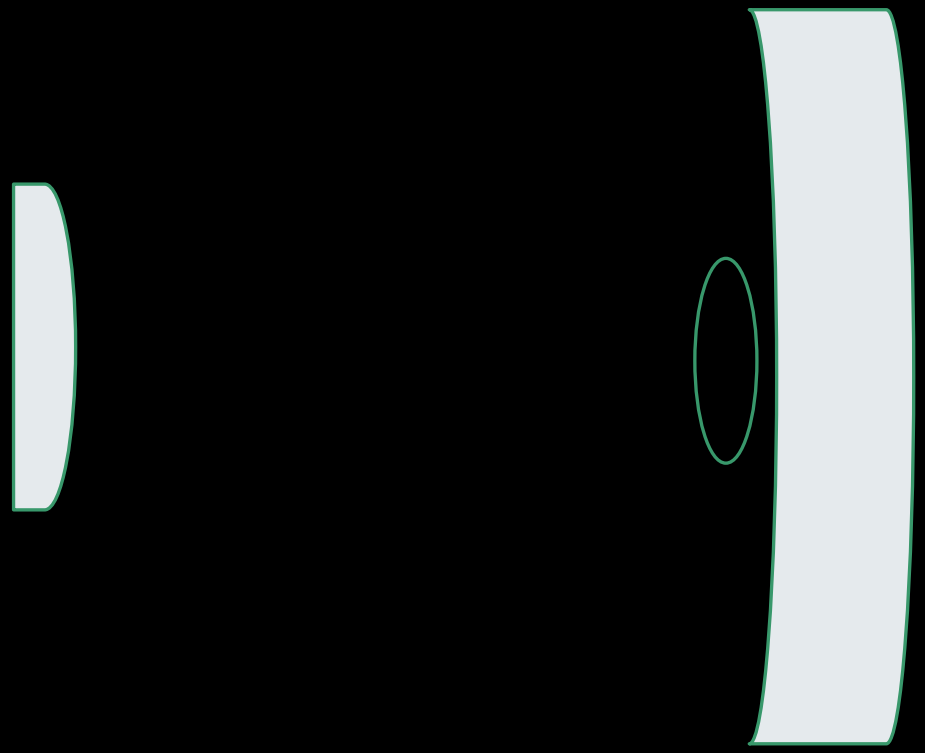


Primary: Parabolic mirror

Secondary: Hyperbolic mirror

Excellent for planets, does suffer from coma

Compound (Ritchey-Chrétien (RC))

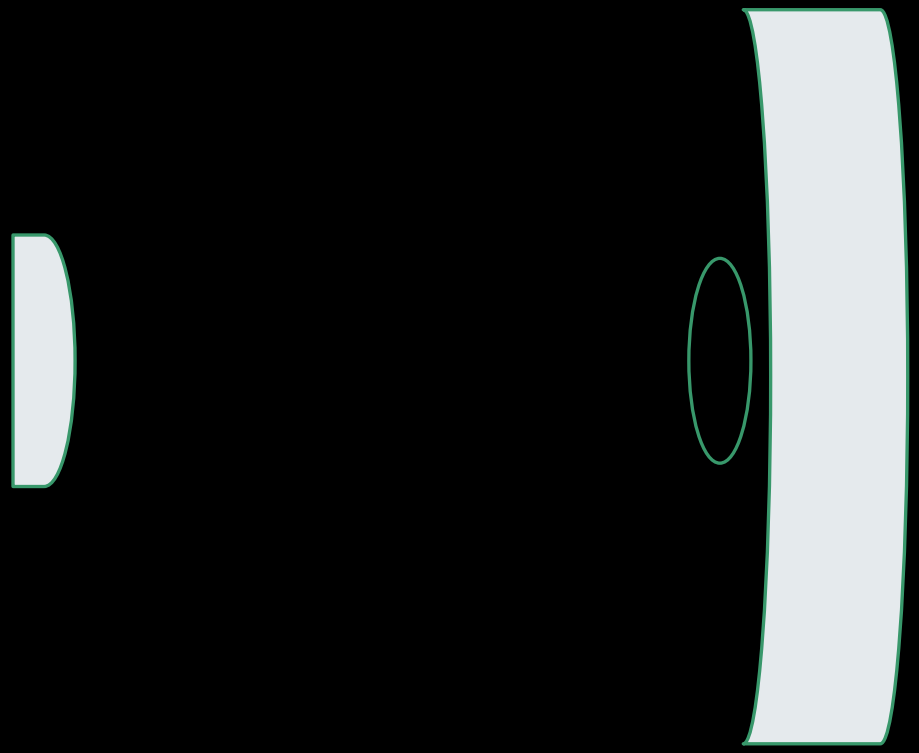


Primary: Hyperbolic mirror

Secondary: Hyperbolic mirror

Excellent for large format imaging, popular among research optical systems. Difficult to collimate due to Hyperbolic mirrors

Compound (Dall-Kirkham)



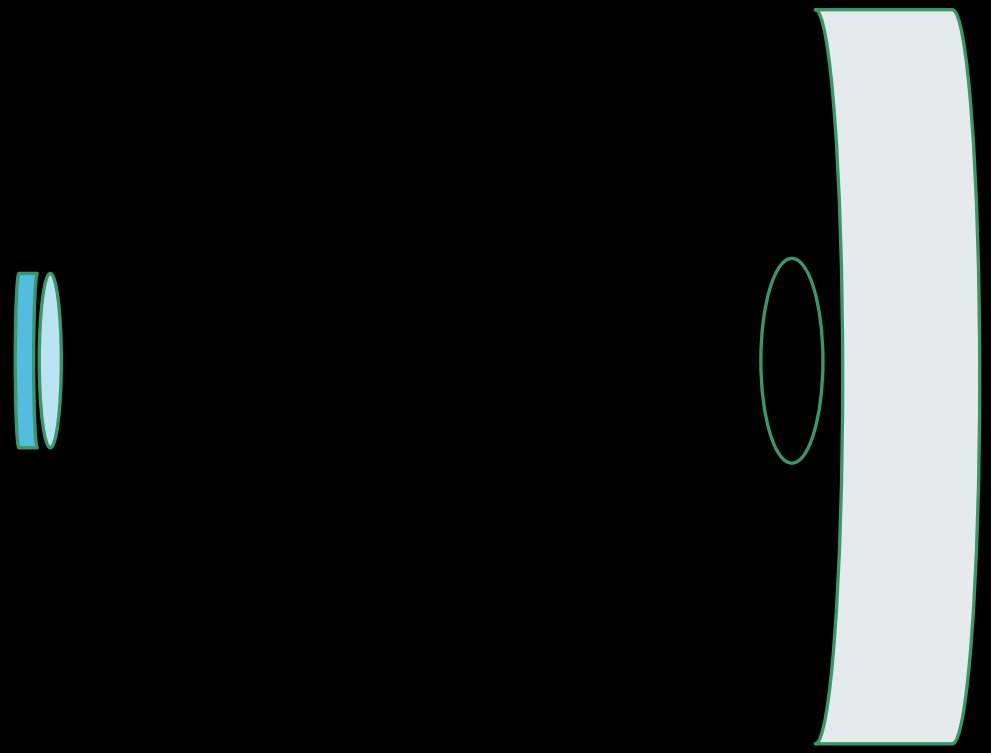
Primary: Elliptical mirror

Secondary: Spherical mirror

Easier to produce than a Classical-Cassegrain can suffer from coma.

Popular for planetary and lunar work due to long focal lengths.

Compound (Rowe-Ackermann Schmidt)



Corrector: Schmidt corrector

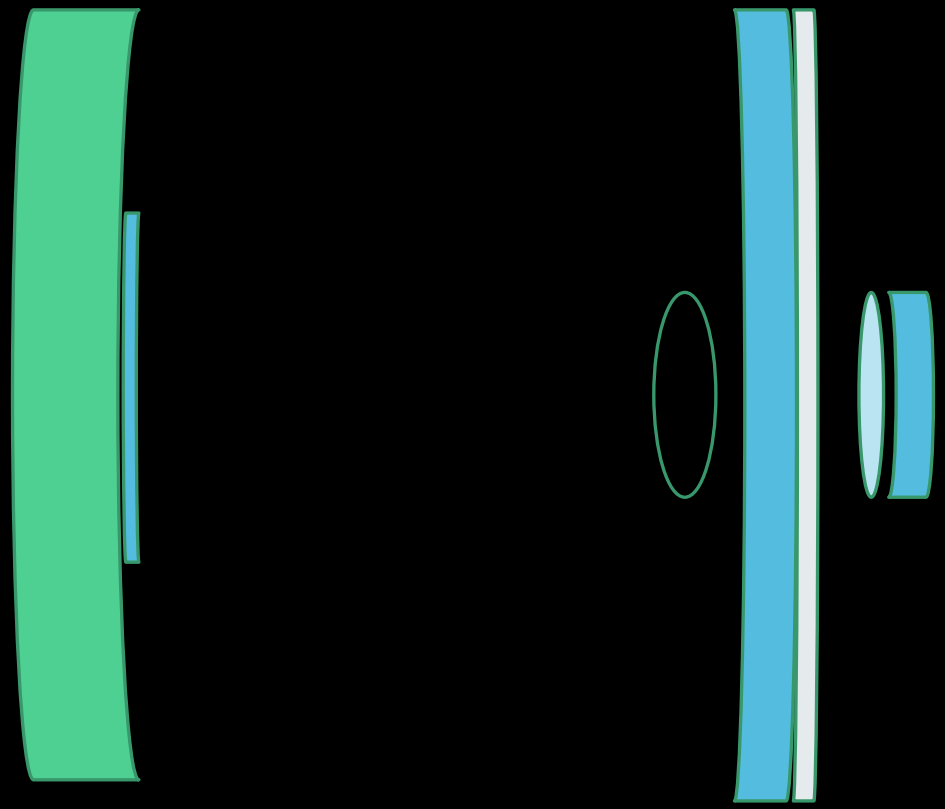
Primary: Spherical mirror

Secondary: Corrective lens assembly

Wide-field imaging system for photographic use only.

Fast f/2 or f/2.2 optics for short exposure work.

Compound (Riccadri -Honders)



Corrector: Corrector Lens

Primary: Mangin Mirror (refractive and reflective)

Secondary: Mirror

Corrector: Two element lens corrector

Highly corrected imaging system for large format cameras.

Large apertures between 8” to 16”, very fast f/2 to f/5 and can handle a wide variety of large format sensors.

Compound & Cassegrains: Advantages

Physical/Mechanical

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Optics

- Good selection of apertures
- Wide variety of configurations
- Good for both photographic and visual applications

Compound & Cassegrains: Disdvantages

Physical/Mechanical

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Physical/Mechanical

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- Focus shift due to moving primary

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Optics

- Difficult to collimate (certain models)

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Optics

- Difficult to collimate (certain models)
- Slow focal ratios

Things to ask yourself

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- Visual
- Photographic
- Both

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