

Astrophotography Tales of Trial & Error

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Photos Through Camera Lens

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Photos Through the Telescope

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Increasing magnification

Camera Basics

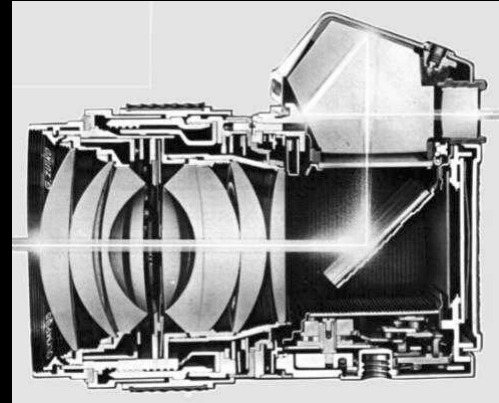
When the photograph is being exposed, the light is directed onto the film. The viewfinder is completely black.

Usual photographic rules apply:

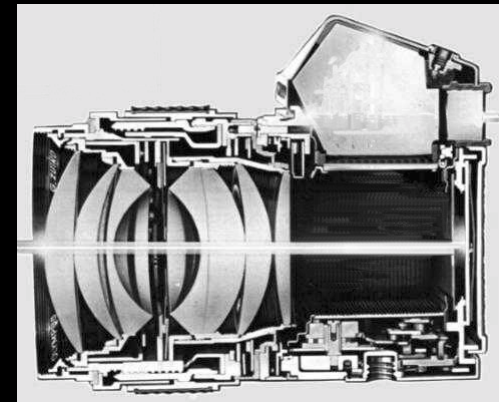
Less light → Longer exposures

Higher f number → Longer exposures

Light directed to viewfinder



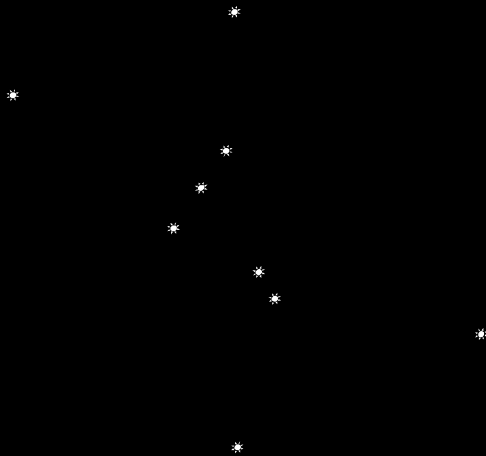
Light directed to film



Star Motion

Stars rise and set – just like the Sun in the daytime.

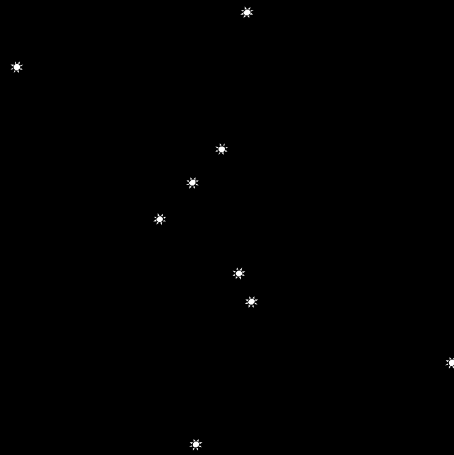
The motion of the stars can cause problems for astrophotography



Star Motion

Stars rise and set – just like the Sun in the daytime.

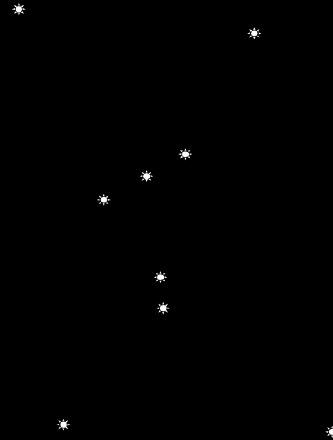
The motion of the stars can cause problems for astrophotography



Star Motion

Stars rise and set – just like the Sun in the daytime.

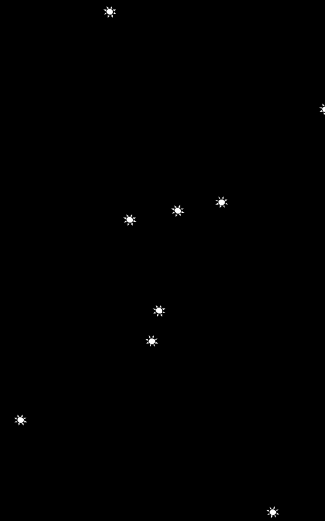
The motion of the stars can cause problems for astrophotography



Star Motion

Stars rise and set – just like the Sun in the daytime.

The motion of the stars can cause problems for astrophotography



Star Motion

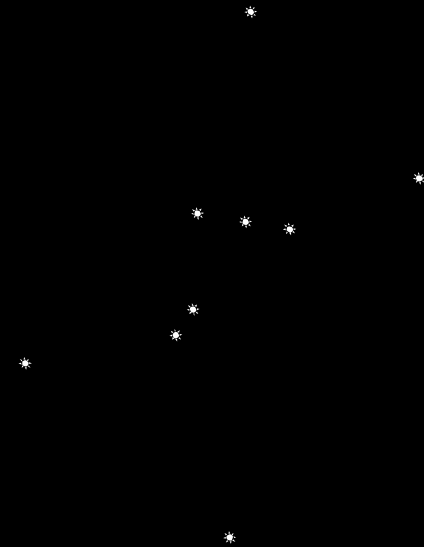
Stars rise and set – just like the Sun in the daytime.

The motion of the stars can cause problems for astrophotography

Tracking the motion of the stars during the exposure is called “guiding”.

Requires a polar aligned mount and periodic corrections to keep the subject stationary relative to the camera.

Done using slow motion controls – or more often with dual axis correctors.



Guiding

Photography Technique	Guiding Required?
Star trails	No
Piggy back	Yes
Prime focus	Yes
Photo through the eyepiece	No – but tracking helps
Eyepiece projection	No – but tracking helps

Star Trails

Mount the camera on a tripod

Point at stars

Open the shutter for 30 mins to 2 hours



Red Rock Canyon

50mm lens @ $f2$

100 ASA Film

~1 hour exposure

Can you tell which direction
The camera was pointing?
(North, South, East or West)

Star Trails

Creative Freedom

- Composition
 - Camera Angle / Direction
 - Field of View
 - Silhouette / Illuminated Foreground
- Subjects
 - Aurora
 - Meteor Showers
 - Dramatic Foreground



Equipment

- Sturdy tripod
- Locking cable release
- Camera with 'B' setting
- Patience

Problems

- Lights – Film is sensitive to light pollution
- Photo Developers – Unusual to get dark skies from photo lab
- Framing – Difficult to see foreground

Solutions

- Find dark site or use light to help with composition
- Write “Astronomy Photos – Please Expose For Dark Sky” on envelope (or use custom developer)
- Practice !

Example Star Trails



Red Rock Canyon
50mm lens @ $f2$
100 ASA Film
~1 hour exposure

Example Star Trails



Saddle Back Butte
28mm lens @ $f2.8$
100 ASA Film
~1 hour exposure

Piggy Back Astrophotography

Mount camera on top of equatorially mounted telescope

Aim at subject and carefully track the movement of the stars

Open the shutter for 5 mins to 2 hours



Nebulosity in Orion

Quartz Hill

300 mm lens @ $f4.5$

800 ASA Film

~20 min exposure

Auto guided

Piggy Back Astrophotography

Creative Freedom

- Composition – Limited Options
 - Field of View (Focal Length of Lens)
 - Special Effects with Filters
- Subjects
 - Constellations
 - Large Galaxies

Equipment

- Equatorial mount (or “Barn Door” mount)
- Brackets – camera to telescope / counter weight shaft
- Locking cable release
- Camera with ‘B’ setting
- Guiding equipment
- Lots of Patience

Problems

- Lights, Photo Developers, Framing
- Polar Alignment – Essential to minimize ‘Field Rotation’
- Exposure
 - Low contrast if too short
 - Sky fog if too long
- Guiding – Difficult to prevent stars drifting



Piggy Back Astrophotography

Problems

- Polar Alignment – To prevent ‘Field Rotation’
- Exposure for dim subjects
 - Low contrast if too short
 - Sky fog if too long
- Guiding – Difficult to prevent stars drifting

Solutions

- Declination drift or polar alignment scope
- Bracket exposures
 - Use fast film (400 ASA or faster)
 - Need dark sky
- Need a guiding eyepiece or auto guider



Auto guiders
Relentless precision of machine
Expensive (5x cost of eyepiece)
Limited applications



Guiding Eyepiece
Human precision (!)
Needs constant attention
Multiple uses

Example Piggy Back Photographs



Andromeda Galaxy

Red Rock Canyon
500 mm lens @ $f8$
800 ASA Film
~45 mins exposure

Auto guided

Example Piggy Back Photographs



Horse head Nebula (NGC B33)

Quartz Hill

300 mm lens @ $f4.5$

800 ASA Film

(Enlargement of previous photograph)

Auto guided

Prime Focus Astrophotography

Mount camera to look through telescope

Aim at subject and carefully track the movement of the stars

Open the shutter for 1/1000 sec to 2 hours



Orion Nebulae (M42 & M43)

Quartz Hill

C8 Telescope @ $f6.3$

800 ASA Film

15 min exposure

Auto guided

Prime Focus Astrophotography

Creative Freedom

- Composition – Limited Options
 - Field of View (Telescope Focal Length)
- Subjects
 - Extended Deep Sky Objects
 - Galaxies
 - Globular Clusters
 - Nebulae
 - Sun & Moon

Equipment

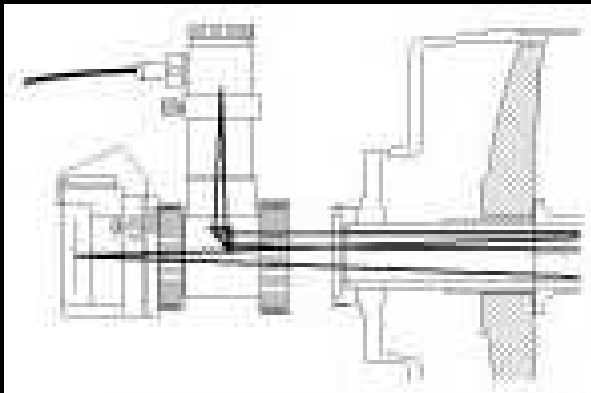
- Telescope with equatorial mount
- Camera adapter
- Focus equipment
- Locking cable release
- Camera with 'B' setting
- Guiding equipment
 - Guide scope
 - Off axis guider
- Even More Patience!!

Problems

- Lights, Photo Developers, Framing
- Polar Alignment, Guiding, Exposure
- Guiding (again)!
- Focusing – subjects may be invisible !



Guiding Prime Focus Photos



Off Axis Guiders

Plus	Minus
Good accuracy – uses the focal length of the telescope	Can sometime be difficult to find a guide star in the field of view
Small and light	Not always easy to reach focus with eyepiece

Guiding Prime Focus Photos



Separate Guide scope

Plus	Minus
Easy to find guide stars	More bulky equipment
Independent focusing of camera and guiding eyepiece / auto guider	Flex between telescope and guide scope causes guiding errors
	Less accurate than off axis guider

Focusing Invisible Subjects

There are a huge number of gadgets to help with focusing.
This indicates the seriousness of the problem!!

Film plane focusing



Bright focusing screens



Focusing masks



Viewfinder magnifiers



Example Prime Focus Photos



Whirlpool Galaxy (M51)

Quartz Hill

C8 @ $f10$

800 ASA Film

~30 mins exposure

Auto guided

(Enlargement)

Example Prime Focus Photos

Orion Nebulae
(M42, M43 & NGC 1977)

Quartz Hill
C5 @ *f*6.3
800 ASA Film
~15 mins exposure

Auto guided



Pinwheel Galaxy (M33)

Example Prime Focus Photos

Mount Pinos

C8 @ f10

800 ASA Film

~60 mins exposure

Auto guided



Example Prime Focus Photos



Crab Nebula (M1)

Quartz Hill
C8 @ $f10$
800 ASA Film
~45 mins exposure

Auto guided

(Enlargement)

Example Prime Focus Photos



Hercules Cluster (M13)

Saddle Back Butte

C8 @ $f10$

800 ASA Film

~15 mins exposure

Auto guided

Example Prime Focus Photos



Lagoon Nebula

Quartz Hill
C8 @ $f10$
800 ASA Film
20 min exposure

Example Prime Focus Photos

Moon

Quartz Hill

C8 @ $f10$

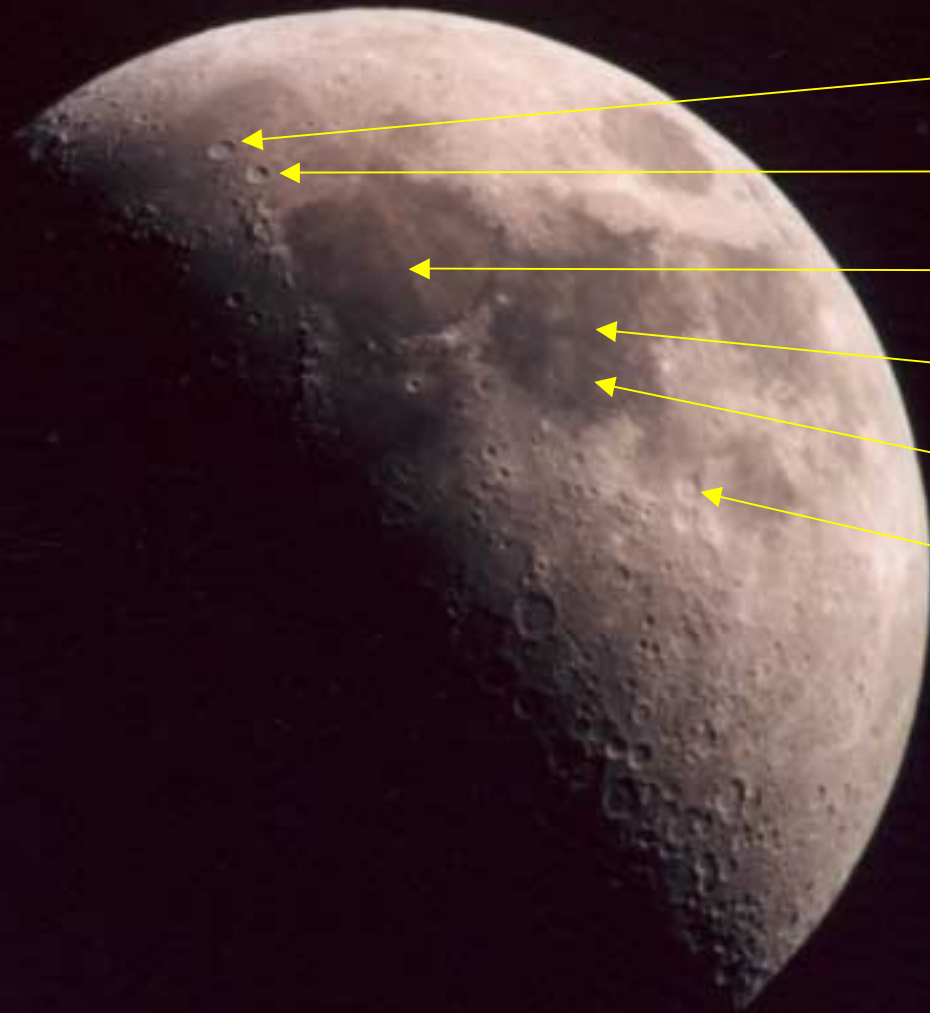
200 ASA Film

1/125 sec exposure

Recognize any features?



Example Prime Focus Photos



Aristoteles

Eudoxus

Mare Serenitatis

Mare Tranquillitatis

Apollo 11 Landing Site

Theophilus

Prime Focus Photos Have
Correct Orientation

Example Prime Focus Photos



Sun

Quartz Hill
C5 @ $f10$
100 ASA Film
1/1000 sec exposure



Quartz Hill
C8 @ $f10$
100 ASA Film
1/1000 sec exposure

WARNING!

Use solar filter over objective!
Cover / remove finder scope!
Remove Telrad!
Do not look at the sun!



Subject Selection

35mm Field Of View - Prime Focus

Long side (deg) = 2073 / focal length (mm)

Short side (deg) = 1382 / focal length (mm)

Examples:

Piggy Prime
Back Focus

2032 mm:	1.02° * 0.68°	(40 X)
1280 mm:	1.62° * 1.08°	(26 X)
1270 mm:	1.63° * 1.09°	(25 X)
800 mm:	2.59° * 1.73°	(16 X)
500 mm:	4.15° * 2.76°	(10 X)
300 mm:	6.91° * 4.61°	(6 X)
200 mm:	10.3° * 6.91°	(4 X)
135 mm:	15.4° * 10.2°	(2.7X)
100 mm:	20.7° * 13.8°	(2 X)

Suggestions

M51 – Whirlpool Galaxy

M42 – Orion Nebula

Rosette Nebula

M31 – Andromeda Galaxy

Veil Nebula

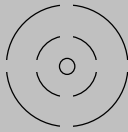
Subject Selection

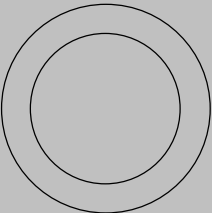
Transparent sheet overlay

Used for framing subjects

CELESTRON[®]

Finders

 Telrad Finder

 6 x 30 Finder
(7 x 50 Finder inside)

35mm Field of View

8" Schmidt Cassegrain

Prime focus @ $f10$ - $1.02^\circ \times 0.68^\circ$

Prime focus @ $f6.3$ - $1.62^\circ \times 1.08^\circ$

5" Schmidt Cassegrain

Prime focus @ $f10$ - $1.63^\circ \times 1.09^\circ$

Prime focus @ $f6.3$ - $2.59^\circ \times 1.73^\circ$

Photo Through The Eyepiece

Mount camera & lens to look through telescope eyepiece

Aim at subject and carefully track the movement of the stars

Open the shutter for 1/1000 sec to 2 sec



Moon – Mare Humorum

Quartz Hill

135mm Lens @ $f2.8$

C8 @ $f10$ 24mm Eyepiece

800 ASA Film

1/2 sec exposure

Gassendi

Photo Through The Eyepiece

Creative Freedom

- Composition – Limited Options
 - Field of View (Telescope Focal Length)
- Subjects
 - Moon / Planets

Equipment

- Telescope
- Tripod
- Camera

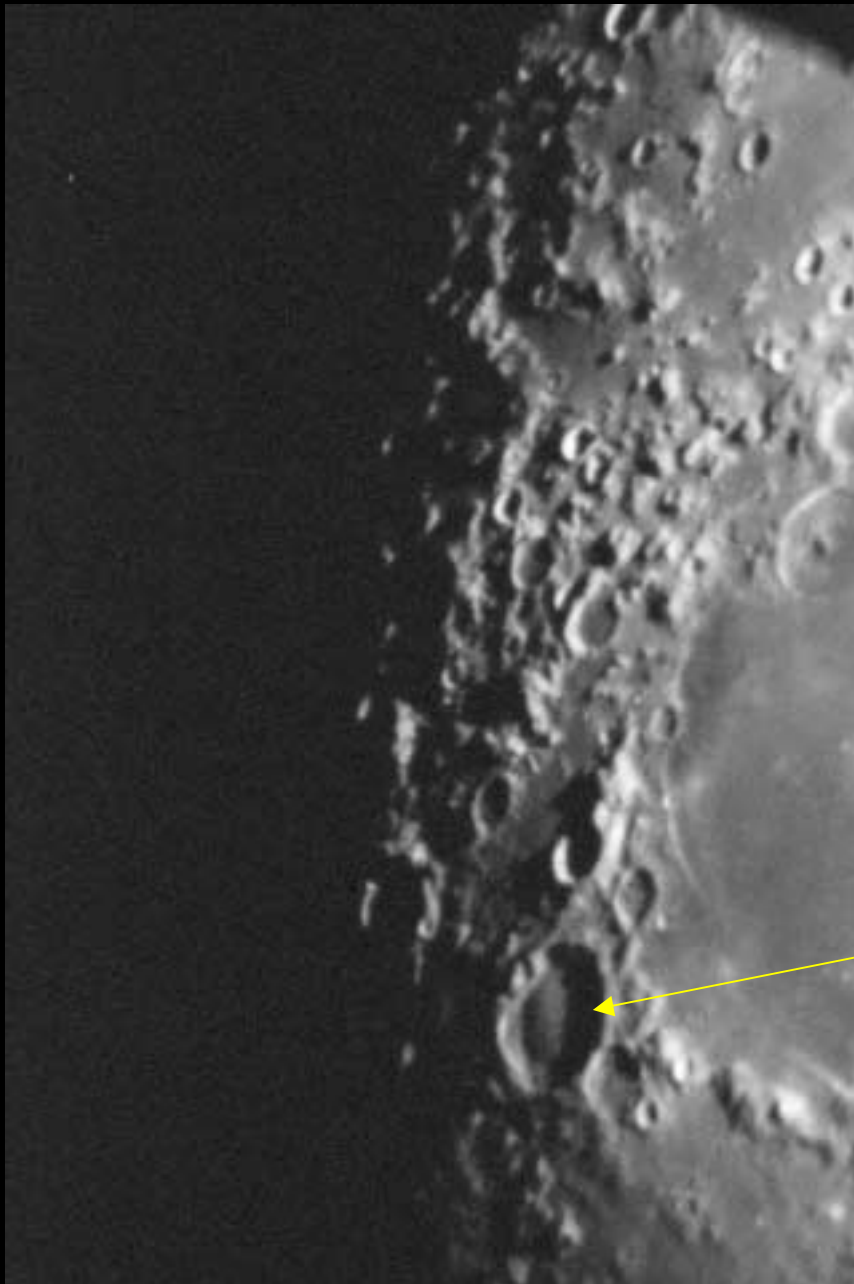
Problems

- Exposure – automatic settings may work
- Blurred image – tripod helps



Note – This works great with
Video Cameras !!

Example Photos Through The Eyepiece



Moon – Mare Humorum

Quartz Hill

135mm Lens @ $f2.8$

C8 @ $f10$ 24mm Eyepiece

800 ASA Film

1/2 sec exposure

Mersenius

Example Photos Through The Eyepiece

Moon – Mare Humorum
Quartz Hill
135mm Lens @ $f2.8$
C8 @ $f10$ 24mm Eyepiece
800 ASA Film
1/2 sec exposure



Eyepiece Projection Photography

Mount camera body to look through telescope eyepiece

Aim at subject and carefully track the movement of the stars

Open the shutter for 1/1000 sec to 2 sec



Moon – Mare Humorum

Quartz Hill

C8 @ f 10

15mm lens @ 150mm

800 ASA Film

1/2 sec exposure

Eyepiece Projection Photography

Creative Freedom

- Composition – Limited Options
 - Field of View (Telescope Focal Length)
- Subjects
 - Moon / Planets

Equipment

- Telescope with equatorial mount
- Camera adapter
- Focus equipment
- Locking cable release
- Camera with 'B' setting
- Objective cover

Problems

- Exposure
- Blurred image – tripod helps
- Unsteady atmosphere can degrade image
- Focus is more critical



Eyepiece Projection Photography



Eyepiece Projection Focal Ratio

$$\begin{aligned}\text{focal ratio} &= f * \text{dist to film} / \text{eyepiece fl} \\ &= 10 * 150 / 15 = 100\end{aligned}$$

$$\text{Focal length} = 100 * 200 = 20,000 \text{ mm}$$

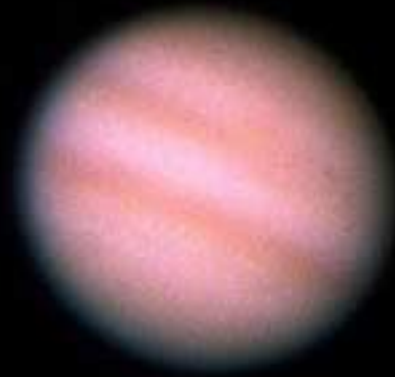
$$\text{Magnification} = 20,000 / 50 = 400X$$

Comment

This is VERY difficult

Not forgiving of focus errors
Even slightest vibration can ruin picture

Example Eyepiece Projection Photos



Jupiter

Quartz Hill

C8 @ f 10

15mm lens @ 150mm

800 ASA Film

1/2 sec exposure

Digitally Enhanced

Example Eyepiece Projection Photos



Jupiter

Quartz Hill

C8 @ f 10

15mm lens @ 150mm

800 ASA Film

1/2 sec exposure

Original Image

Example Eyepiece Projection Photos



Saturn

Quartz Hill

C8 @ $f10$

15mm lens @ 150mm

800 ASA Film

1 sec exposure

Moon – Sinus Iridum
Quartz Hill
C8 @ $f 10$
15mm lens @ 150mm
800 ASA Film
1/2 sec exposure

Example Eyepiece Projection Photos

Bianchini – 25 miles wide





Acknowledgments



Marie Allen – Patience and Understanding

Martin Gerhold & John Eakin – Scanning Photographs

Bill Ellison – Driving Van to Red Rock Canyon



The End

