Scope

- Digital Cameras with lens that do not remove
Lunar Imaging is a Good Starting Point

- It is 2\textsuperscript{nd} brightest object
- The Sun requires an expensive filter
- Wide variety of equipment
  - Camera Mounted on Tripod
  - Telescope low, median and high resolution
- Noticeable changes within hours
- Very good learning for other imaging
Camera Mounted on Tripod

- Focus at infinity
- Vary the exposure times
- Vary the optical zoon
- Use self timer or
- Remote shutter
Camera Mounted on Tripod
Camera Mounted on Tripod

- Jupiter
- Moon
- Venus
- Mars

2002.05.15 22:04
Camera Mounted on Tripod
Camera Mounted on Tripod

Venus
Camera Mounted on Tripod

2x Telephoto Lens

Image 85 x 112 pixels
1/250 sec.
Camera Mounted on Tripod
Camera Mounted on Tripod

Venus
Tips

- Lens converts
  - Manual focus distances are not correct

- Remote release cable
  - Improves productivity
Imaging with Telescopes

Orion ShortTube

Orion Argonaut
Orion ShortTube Telescope

- Achromatic refractor
- 80mm aperture
- 400mm focal length
- f/5 f-ratio

Orion SVD mount
Orion Argonaut Telescope

- Maksutov-Cassegrain
- 150mm aperture
- 1800mm focal length
- f/12 f-ratio

Orion EQ-3 Mount
Tip: Use Vibration Suppression Pads
Afocal Coupling

Camera is aimed into the eyepiece

- Eyepiece
- Camera with non removable lens
**Afocal Coupling**

**Basic Formulas**

- \( D = \text{Telescope aperture} \)
- \( F_t = \text{Telescope focal length} \)
- \( f_t = \text{Telescope focal ratio} = F_t / D \)
- \( F_{c} = \text{Camera focal length} \)
- \( F_{ep} = \text{Eyepiece focal length} \)
- \( \text{Magnification} = F_t / F_{ep} \)
- \( \text{Projection Magnification} = F_c / F_{ep} \)
- \( \text{Effective Focal Length} = F_t \times \text{Projection Magnification} \)
- \( \text{Effective} \ f\text{-ratio} = f_t \times \text{Projection Magnification} \)
Projection Magnification = \( Fc / Fep \)

<table>
<thead>
<tr>
<th>Ep (mm)</th>
<th>( Fc = 8.2 \text{ mm} )</th>
<th>( Fc = 23.4 \text{ mm} )</th>
</tr>
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<tbody>
<tr>
<td>9.5</td>
<td>0.86</td>
<td>2.46</td>
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<tr>
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<td>0.82</td>
<td>2.34</td>
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<tr>
<td>14</td>
<td>0.59</td>
<td>1.67</td>
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<tr>
<td>18</td>
<td>0.46</td>
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<tr>
<td>26</td>
<td>0.32</td>
<td>0.90</td>
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### Orion ShortTube F = 400mm, \( f = 5 \)

<table>
<thead>
<tr>
<th>Ep mm</th>
<th>Zoon Out</th>
<th>Zoon In</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F mm</td>
<td>( f )-ratio</td>
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<tr>
<td>9.5</td>
<td>345</td>
<td>4.3</td>
</tr>
<tr>
<td>10</td>
<td>328</td>
<td>4.1</td>
</tr>
<tr>
<td>14</td>
<td>234</td>
<td>2.9</td>
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<td>18</td>
<td>182</td>
<td>2.3</td>
</tr>
<tr>
<td>20</td>
<td>164</td>
<td>2.1</td>
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<tr>
<td>24</td>
<td>137</td>
<td>1.7</td>
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<tr>
<td>26</td>
<td>126</td>
<td>1.6</td>
</tr>
</tbody>
</table>
### Orion Argonaut F =1800mm, f = 12

<table>
<thead>
<tr>
<th>Ep mm</th>
<th>Zoon Out</th>
<th>Zoon In</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F mm</td>
<td>f-ratio</td>
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<tr>
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<td>14</td>
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<td>18</td>
<td>820</td>
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<td>20</td>
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<td>24</td>
<td>615</td>
<td>4.1</td>
</tr>
<tr>
<td>26</td>
<td>568</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Afocal Coupling

- Camera is aimed into the eyepiece
- Hold the camera over the eyepiece
- Set camera on tripod next to telescope
- Use bracket attached to eyepiece
- Use camera adapter
- Use eyepiece with adapter
Afocal Coupling
Afocal Coupling

Afocal Camera Adapter
Nikon 990 Camera
Afocal Camera Adapter

CKC Power 28mm to T-mount adapter
Orion 20mm eyepiece
Orion Universal Camera adapter
Edmund Scientific 48mm Barrel T-mount extension tubes
Nikon 990 Camera
Afocal Camera Adapter
Afocal Coupling Telescope Mounting

Edmund Scientific
48mm Barrel T-mount
Split ring mount
Afocal Coupling
Eyepieces with Adapter or Threads
Nikon 990 Camera
Afocal Eyepiece with Adapter
Nikon 990 Camera
Afocal Eyepieces with 28mm Threads

24mm Eyepiece

28mm Threads

18mm Eyepiece
Nikon 990 Camera
Afocal Eyepiece with 28mm Threads
Nikon 990 Camera
Afocal Eyepiece with 28mm Threads
Nikon 990 Camera
Afocal Eyepiece with 28mm Threads
Vignetting when Zoom Out
Imaging Setup

- Polar alignment
- Power
- Camera
- Dew heater
Tip: Cool Down

Plan for cool down time
Nikon Camera Settings

- Manual mode
- Manual focus at infinity
- White balance: sunny
- Image sharpening: high
- Aperture wide open
Tip: Use Lowest ISO Setting

- Take test images
- At different ISO settings
- More noise at higher ISO settings
- 200 and 400
Tip: Use Lowest ISO Setting

SHUTTER : 1/125sec
SENSITIVITY : ISO400

SHUTTER : 1/60sec
SENSITIVITY : ISO200

SHUTTER : 1/30sec
SENSITIVITY : ISO100
Tip: Use Lowest ISO Setting

SHUTTER : 1/125sec
SENSITIVITY : ISO400

SHUTTER : 1/60sec
SENSITIVITY : ISO200

SHUTTER : 1/30sec
SENSITIVITY : ISO100
Focusing

- Manual focus at infinity
- Image sharpening: high
- Maximum digital zoom
Tip: Electric Focuser

JMI NGF-S DRO Focuser
Steps to a Good Sharp Exposure

Everything is Dependent on Seeing Conditions

- Seeing
- Telescope
- Eyepiece
- Camera Zoom
- Exposure Time
- Image Exposure
- Image Sharpness
Poor Seeing
Good Seeing, No Image Processing
Good Seeing, Image Sharpen

<table>
<thead>
<tr>
<th>F mm</th>
<th>f-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2340</td>
<td>15.6</td>
</tr>
</tbody>
</table>
Exposure

Over Exposed

1/8 sec

1/4 sec
Image Exposure

Take one image & check histogram
8 sec Image Exposure Problems

- Achromatic Refractor
- False Color
- Camera Noise
- Lens Flair
Shutter Release

- Shutter-release button
- Self-timer
- Shutter Release Controller
- Shutter Release Software with PC
Remote Release Cable

Nikon MC-EU1 Remote Cord
Shutter Release Controller

DigiSnap 2000

http://www.harbortronics.com/digimain.htm
Shutter Release Software

The Force

http://velatron.com/dca/TheForce/
Shutter Release Software

Digital-Camera.dk

http://www.digital-camera.dk/
Partial Solar Eclipse Movie

June 10, 2002
Partial Solar Eclipse
David Haworth
Partial Solar Eclipse Movie

- June 10, 2002
- 130 images @ 1 minute apart
- 17:00 to 19:08
- Nikon 990 Digital Camera
- Orion 80mm ShortTube refractor
Partial Solar Eclipse Movie Steps

- Convert JPG image files to BMP
  - IrfranView
- Align
  - MaxIm DL
- Resize from 2048 x 1536 to 640 x 480
  - IrfranView
Partial Solar Eclipse Movie Steps

- Sharpen
- IrfranView
- Histogram adjust
- Paint Shop Pro
- Create Windows Media Video WMV file
- Windows XP Move Maker 2
Partial Solar Eclipse Movie
Planets

- Real Small
- Requires high magnification
- Stacking is must
Planet Stacking

One image

Stacked Images

22 Stacked & Processed
OSP 2003 Mars
Wednesday August 27, 3:11 am

29 Stacked Images 1/125 sec
OSP 2003 Mars

Nikon 990
  29 Stacked Images 1/125 sec
  Wednesday August 27, 3:11 am

ToUcam webcam
  660 Stacked Images 1/125 sec
  Thursday August 28, 11:10 pm
More Information

Will post presentation & references on website by end of September

http://www.stargazing.net/david