Amateur Solar Observing

- or -

How not to fry your eyeball!
Why observe the sun?

• No more late nights

• Light pollution? What’s that?

• Ever-changing surface

• Impacts to society

• Just plain cool!
Obligatory safety warnings

• No horseplay, ever

• Don’t leave solar scopes unattended

• Inspect equipment for damage before use

• Avoid “screw into the eyepiece” solar filters!!!
Ways to Observe The Sun

• Positions of the sun in the sky
  – Rise/set locations
  – Analemma
  – Pinhole camera

• Surface features and eclipses
  – Pinhole projection
  – Eyepiece projection
  – Filters
    • White light filter
    • Narrow-band filters (Hydrogen-alpha, Calcium K)
Rise/Set Location

- Used since ancient times
- Pick stable sighting point, note where sun rises/sets each day
- Note the north (summer) and south (winter) extremes at solstices
- Where does sun rise/set at equinox?
Analemma

- Record position at same time each day (correct for daylight savings!)
- Composite photographs
- Sketch shadow on ground
- Solstice at ends, equinox at crossover
- “Figure 8” due to Earth’s elliptical orbit, axial tilt
Pinhole Cameras

• Photograph path of sun through the sky
• Photo paper, film canister and time
• Talk to Becky Ramotowski for details!

Photos by Becky Ramotowski
Pinhole Projection

- Cheap and easy eclipse viewing
- Two cards, one with tiny hole in it
- Forms image on second card
- Nature also provides “pinholes”

Christmas Day, 2000, Eagle River, WI
Eyepiece Projection

• Eclipses and sunspots
• Use simple eyepieces with fewer elements (e.g., Kelner), stop down objective
• Also works with binocs
• NEVER look into eyepiece!!
Solar Filters

Hydrogen alpha

Calcium K

White light
One Sunspot, Three Views

Each filter shows a different layer of the sun and its atmosphere.

- **Hydrogen alpha**
  - Shows the **Chromosphere** – “Sphere of Color” (lowest layer of solar atmosphere, 2500km)

- **Calcium-K**
  - Shows the **Photosphere** – “Sphere of Light” (sun’s “surface”)

- **White Light**
  - Shows the **Chromosphere** – “Sphere of Color” (lowest layer of solar atmosphere, 2500km)
White Light

- Passes whole spectrum
- $30-40 for small scope
- Make at home from Baader AstroSolar film
Features to Look For in White Light

- Umbra
- Penumbra
- Faculae
- Fibrils
Calcium-K

• Isolates “K” emission line of Calcium
  – $800-2000
  – Deep violet end of the spectrum
  – Primarily used as an imaging band
Features to Look For in Calcium-K Light

Plage

Spot

Active Region
Hydrogen Alpha

• Isolates just hydrogen alpha emission
  – $500-8,000+
  – Aperture and bandpass (< 0.5-1.0 angstrom)

• *Not* same kind as used for night astrophotos
Features to Look For in Hydrogen Alpha Light

- Prominence
- Filament
- Plage
- Flare
- Spot
- Active Region
Filter Suppliers

• White light
  – Baader Planetarium AstroSolar film
  – Various vendors – film, glass

• H-alpha
  – Lunt
  – Coronado (Meade)
  – Solar Spectrum
  – Solarscope
  – DayStar

• Calcium-K
  – Lunt
  – Coronado (?) – used to have a CaK PST
  – Baader Planetarium
Recording the Views

- Sketching
- Afocal imaging
- Fast framerate imaging
Sketching

• Traditional, personal flavor and feel to record
• Simple materials
  – Mechanical pencils
  – Artist pencils, pastels
  – Felt pens
• Hones your eye to see more detail
DKC  

Cao  

127 mm Mak., 25 mm Plossl, 2x Barlow.  
~1845 L, 1645 UTC  

Sunspot 930  
10 Dec 1435 L  
1335 UTC  
25 mm Plossl, 2x Barlow  

Suggestion of light lane  

PST H-α  
15 mm Plossl
Afocal Imaging

- Hold camera to eyepiece
- Works w/ many cameras

Photos by Becky Ramotowski
Fast Framerate Imaging

• “Freeze the seeing”
• Stacking video frames improves image quality
• Scope, filter, camera, computer (sundog not req.)
Types of Cameras

• Webcam, $30+
  – Sony SPC900NC

• Solar System Imager, $100+
  – Orion StarShoot line
  – Meade LPI
  – Celestron NexImage

• Dedicated Planetary Cameras, $390+
  – Imaging Source DMK line
  – Lumenera SKYnyx
  – Point Grey Research Flea3

• Higher-end cameras usually offer better sensitivity, resolution, more sophisticated camera controls
B/W vs. Color Imaging

• Color – convenience
• B/W – sensitivity and resolution
• High-end imagers use B/W and colorize in post-processing

![Only some pixels sensitive to each color](image1)

![All pixels equally sensitive (better resolution)](image2)
How Does Fast Framerate Imaging Work?

• Record video

• Assess individual frames, reject bad ones

• Stack remaining frames

• Post process image (sharpen, crop, color, mosaics, etc.)
Record Video

• Several hundred to several thousand frames
  – 15-60 frames per second

• Number of frames is subjective
  – Bad seeing = more frames
  – More magnification = more frames

• Focus is critical
Assess Individual Frames

- RegiStax software does this automatically

- Select alignment feature(s)

- Set cutoff to accept or reject frames
  - More frames = better image (usually!)
  - Don’t keep bad frames just to boost count
RegiStax5

Select one or more regions to align on.
RegiStax5

Set cutoff for keep/reject
Stack Remaining Frames

• Combines each frame, averaging pixel value

• Less noisy than single frame
RegiStax5

Reference points

Frames being processed
RegiStax5
Sharpen Image

• Apply digital sharpening to the image

• Easy to over do it and induce artifacts
  – Better to under-use wavelets than go too far

• Don’t ask me how it works...
RegiStax5

Wavelets controls
Tips and Hints

• Shade computer screen outdoors
• Use deep green or red filter w/ white light filter
• Improve “seeing”
  – Shoot early in day
  – Avoid shooting over parking lots, roof tops
• Save images in stages to allow “do over”
• Get a huge hard disk and/or external drive
• Get as much RAM as you can
Upcoming Solar Events

• Annular Eclipse – 20 May 2012
  – Visible from ABQ but sets during egress

• Venus Transit – 5 Jun 2012
  – Last one for over a century!
  – Visible from ABQ but sets mid-transit

• Total Eclipse – 13 Nov 2012
  – Not visible from US
  – Australia, anyone?
Solar-Related Websites

- CloudyNights: www.cloudynights.com
- SpaceWeather: www.spaceweather.com
- Solar Dynamics Observatory: http://sdo.gsfc.nasa.gov/
- SunGazer: http://sungazer.net/
- Averted Imagination: http://avertedimagination.com/
- Analemma: http://www.analemma.com/Pages/framesPage.html
Sun in hydrogen alpha, tuning filter across h-a center frequency
Solar Prominences in Hydrogen alpha, 90 minute time lapse
Beyond Solar

• Use same techniques on moon and planets
Filter can be tuned slightly three ways: changing the plate (mirror) spacing of the etalon, tilting the filter, or changing the temperature of the filter.