Solar Imaging and Observation

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White Light Solar Imaging and Observing

NEVER LOOK DIRECTLY AT THE SUN OR THROUGH A TELESCOPE WITHOUT A SOLAR FILTER

Hydrogen Alpha filtering will provide more detail than white light filtration. However, hydrogen alpha filtering can be very expensive depending upon the system. For this reason, white light filtering was chosen. Neutral density (ND) filters may also be needed to reduce the light and increase contrast depending upon the camera used. The Lunt Herschel wedge has a built in ND filter. There are hundreds of different configurations and at various costs. Below is just one. Alternately, the camera and camera adapter may be replaced by an eyepiece and filters for observation use without imaging.

A Herschel wedge is a right angle prism used to refract most of the light out of the optical path, allowing safe visual observation. It was developed by astronomer John Herschel in the 1830s.

The Telescope Camera Adapter with a T mount specific for Nikon Z cameras allows the camera to connect to the wedge. Other cameras will require a different T mount. The camera adapter chosen allows for magnification by adding an eyepiece inside the adapter. In this setup, a 15 mm eyepiece was used inside the camera adapter. The back focus ability of the telescope will limit the focal length of the eyepiece that can be used. To find the sun, the camera and camera adapter with a 15 mm eyepiece was temporarily replaced with a 40 mm eyepiece onto the Herschel Wedge. After the sun was found and telescope aligned with it, The 40 mm eyepiece was replaced with the camera and adapter containing the 15 mm eyepiece. A Baader Continuum filter may enhance the image, but none were available during the time of this writing.

The Nikon Z5 mirrorless camera used in this configuration has an electronic shutter. Set it to silent mode and use the snap bridge app for remote control so as not to shake the camera using the shutter release button. A shutter speed of at lease 1/2500 and an aperture of f/8 was used. Alternatively, use the interval timer built into the Nikon camera in place of the snap bridge app.

The Manfrotto geared head was used on a tripod. To increase elevation, rotate the head 180 degrees and use it backward.

In figure 3, sun spots can be seen, but not prominences. A hydrogen alpha telescope would be required to see prominences on the sun as shown in the next section.

This image was photographed through a high quality glass door. Previous tests on trees demonstrated the glass did not affect the quality of the image.

Yes, the sun can be imaged from an air conditioned house as seen from the photo above.

The sun is so large that 190 Earth's side by side would fit across the sun's diameter.

The same setup can be used for night time imaging by replacing the Herschel Wedge with a standard 1.25 inch prism or mirror diagonal. The moon will appear the same size as the sun, which is why we can see total eclipses. For a wider field of view, remove the 15 mm eyepiece.

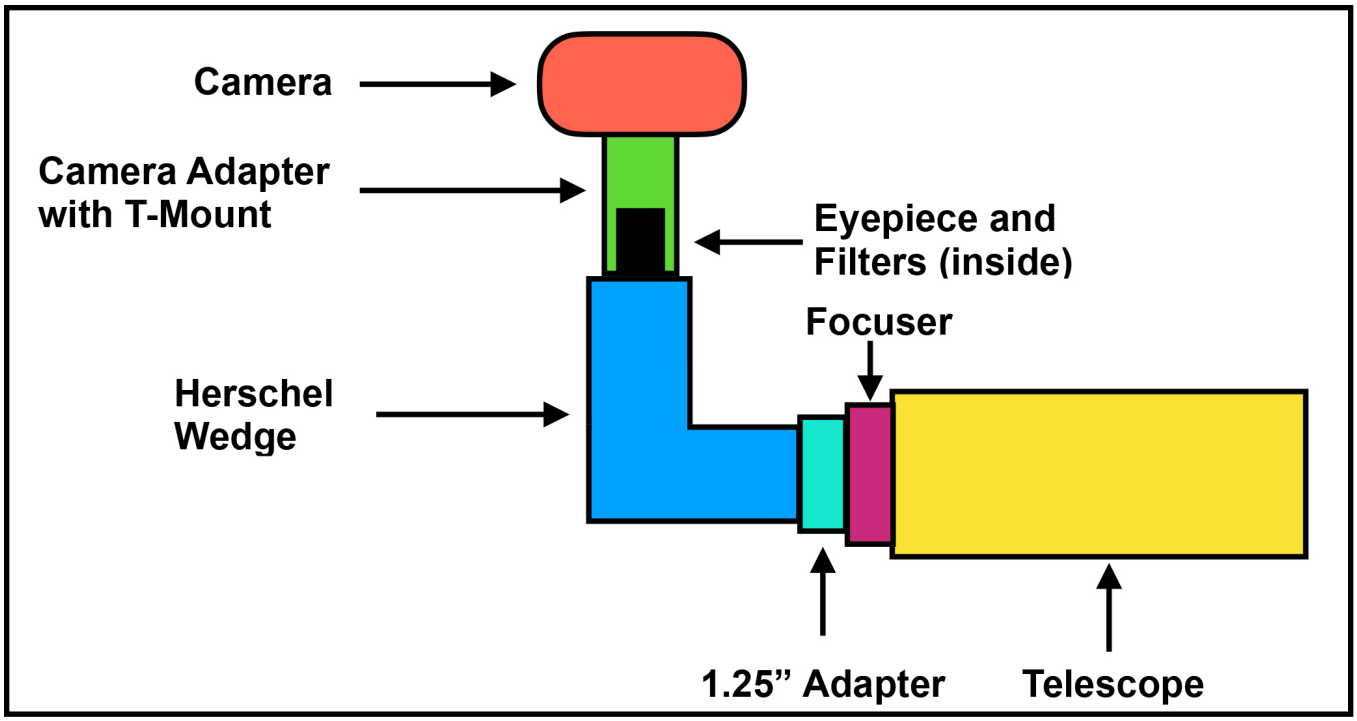


Figure 1 - Telescope Imaging Configuration

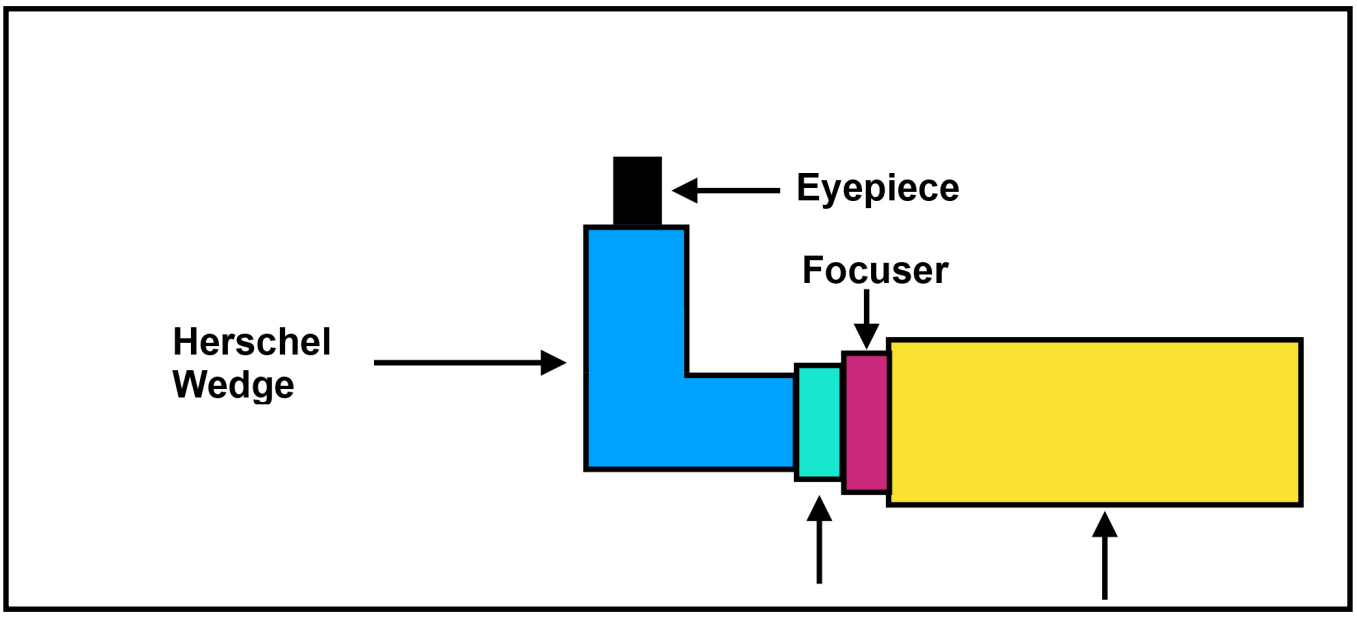
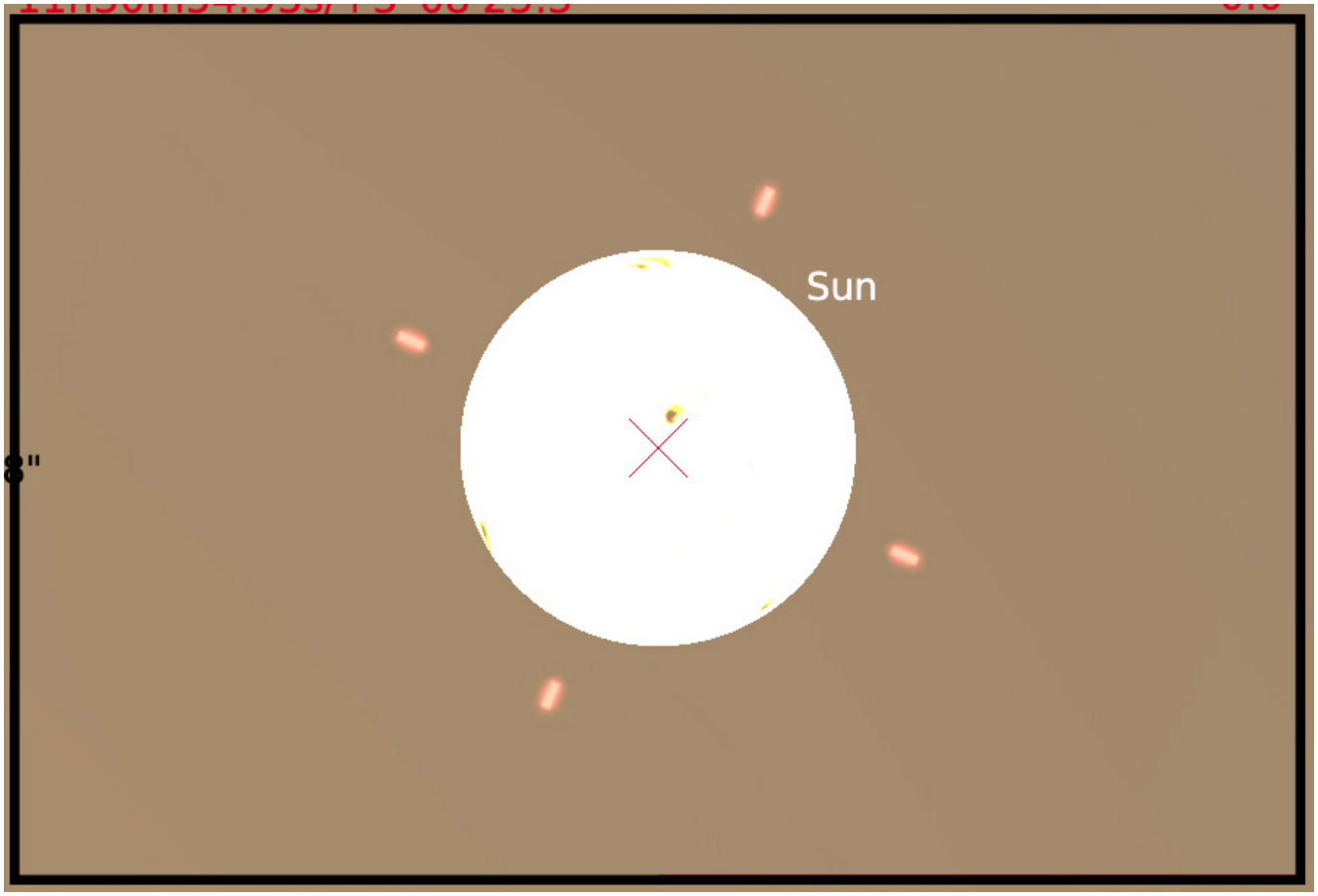


Figure 2 - Telescope Observing Configuration

Figure 3 - Solar Image August 23, 2023, 3:38 pm

Figure 4 - Complete Telescope Setup



Simulation of the sun with a full frame camera and a 600 mm lens with 2x teleconverter

Resources

William Optics Zenithstar 61 mm Doublet Refractor Telescope - Blue Edition, with 1.25” eyepiece adapter
$478

Lunt 1.25" Solar Wedge (Herschel wedge) for refractors LS1.25HW
$291

SVBONY Telescope Camera Adapter Kit Extendable Prime Focus and Variable Projection Eyepiece Connect 1.25 inches Reflector Telescope Photography
$40

SVBONY Telescope Eyepiece 1.25 inches Telescope Accessory 68 Degree Ultra Wide Angle Astronomy 15 mm
$36

SVBONY Telescope Eyepiece 40mm 1.25 inches Plossl Telescope Lens Fully Multi Green Coated Metal 40 Degree Apparent Field 4 Element Telescope Accessory for Astronomy Telescope
$21

Vello T-Mount Lens to Nikon Z-Mount Camera Lens Adapter
MFR #LA-NZ-T
$13.50

Nikon Z5, 24 mp Mirrorless Camera
$1,295

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Manfrotto MT055CXPRO4 055 Carbon Fiber 4-Section Tripod with Horizontal Column
$490

Manfrotto 410 Junior Geared Head with 410PL Quick Release Plate
$337

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Or

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Sky-Watcher AZ-GTi Multi-Purpose Mount & Tripod
Not the best, but inexpensive
==========
$475

Or
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Sky-Watcher SolarQuest Alt-Azimuth Solar Mount
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Hydrogen Alpha Solar Imaging and Observation

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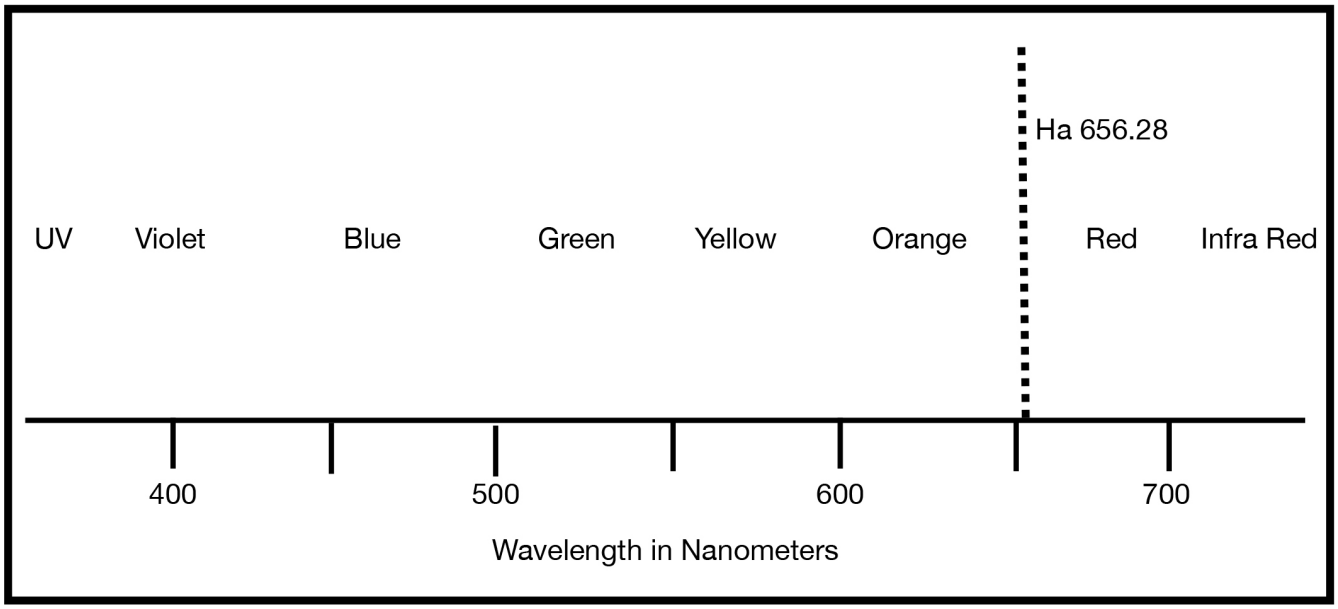

The light from the Sun at the H-alpha frequency (656.28 nanometers) comes from a layer of hydrogen gas that is above the surface of the Sun. This hydrogen layer is called the solar chromosphere. It is only visible through a filter that is within the bandwidths of hydrogen alpha light. The chromosphere contains magnetic energy and it is where the primary solar activity can be observed including filaments, prominences, spicules and active regions. The view is accomplished using the combination of the etalon narrow band filter and hydrogen alpha blocking filter, which blocks all wavelengths of light except hydrogen alpha. There are hundreds of different configurations and at various costs. Below is just one. Alternately, the camera and camera adapter may be replaced by an eyepiece for observation use without imaging.

The Telescope Camera Adapter with a T mount specific for Nikon Z cameras allows the camera to connect to the wedge. Other cameras will require a different T mount. The camera adapter chosen allows for magnification by adding an eyepiece inside the adapter. In this setup, a 15 mm eyepiece was used inside the camera adapter. The back focus ability of the telescope will limit the focal length of the eyepiece that can be used. To find the sun, the camera and camera adapter with a 15 mm eyepiece was temporarily replaced with a 40 mm eyepiece onto the Herschel Wedge. After the sun was found and telescope aligned with it, The 40 mm eyepiece was replaced with the camera and adapter containing the 15 mm eyepiece.

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The Manfrotto geared head was used on a tripod. To increase elevation, rotate the head 180 degrees and use it backward.

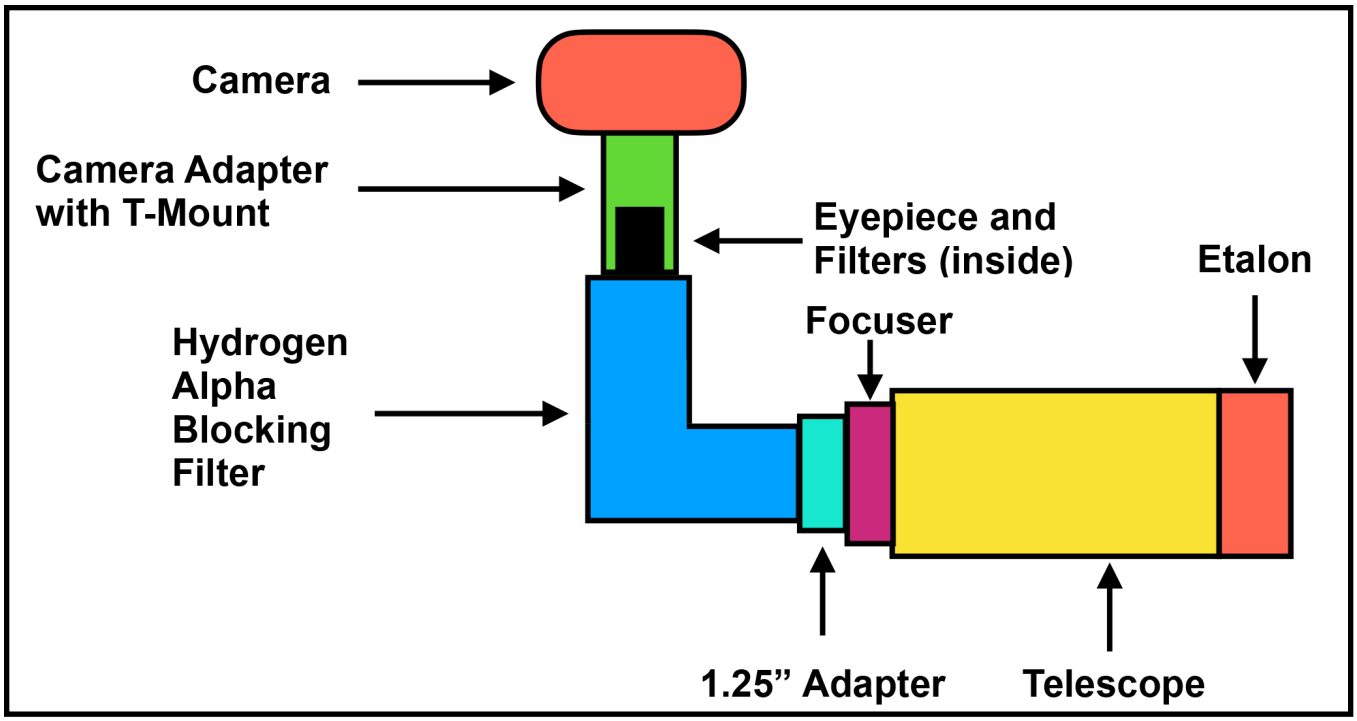
In figure 3, prominences can be seen using a hydrogen alpha telescope.

Also this image was photographed through a high quality glass door. Previous tests on trees demonstrated the glass did not affect the quality of the image.

Yes, the sun can be imaged from an air conditioned house as seen from the photo to right.

Due to some user problems, the Etalon was not adjusted and the imaging session needed to be abandoned. Further sessions were not arranged.

The sun is so large, 190 Earth’s side by side would fit across the sun’s diameter.



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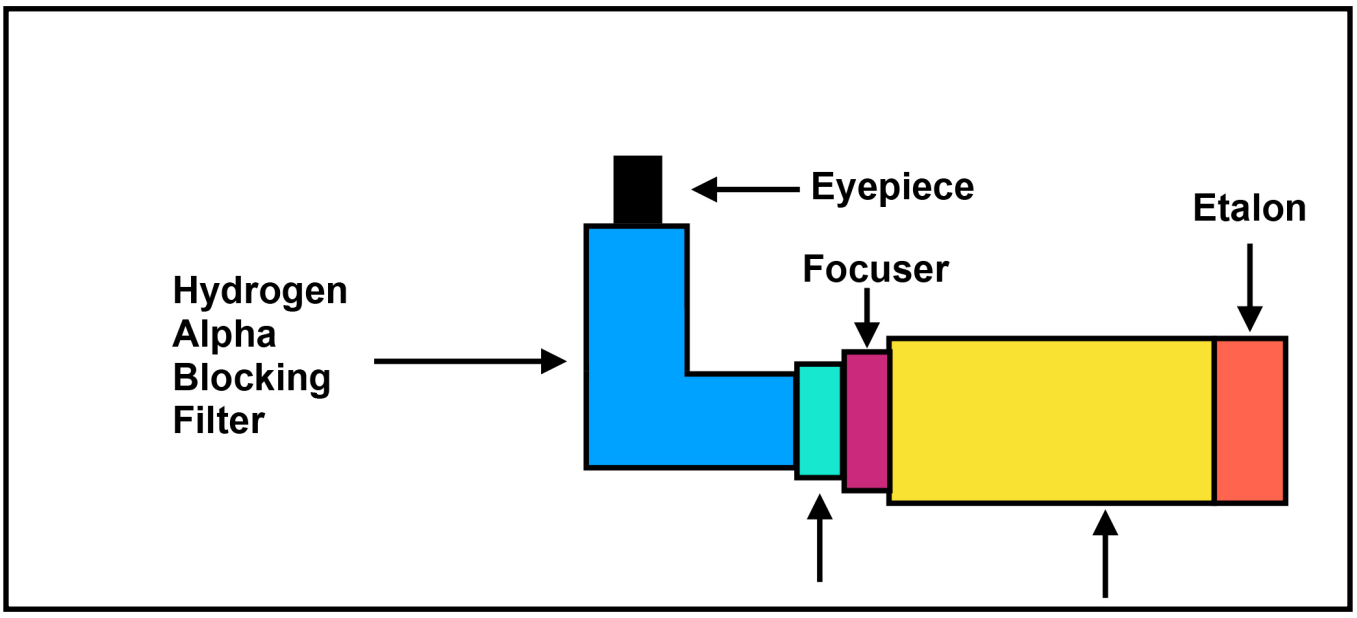

Figure 2 - Telescope Observing Configuration

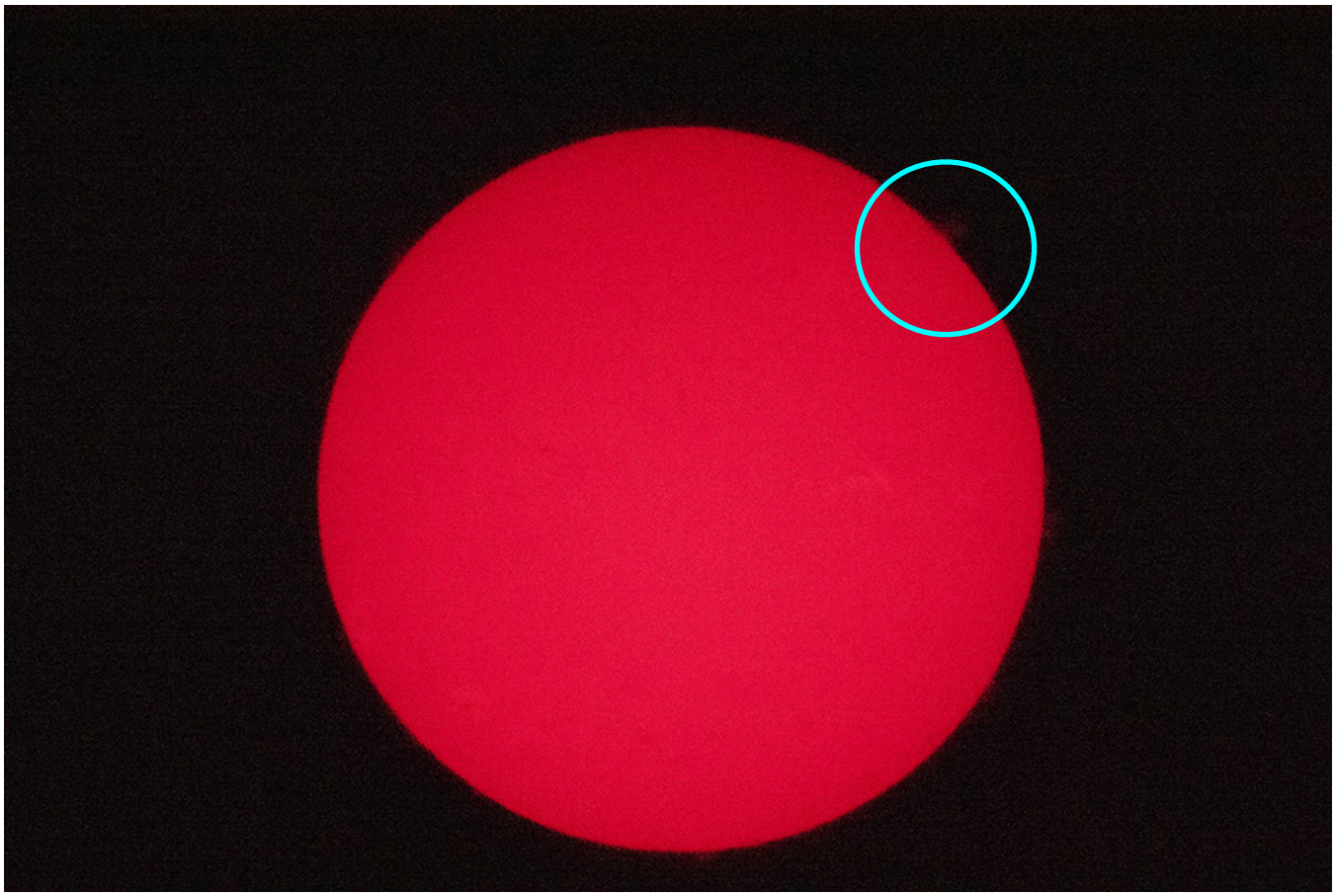

Figure 3 - Solar Image in Hydrogen Alpha September 1, 2023, 4:12 pm

Figure 4 - Complete Telescope Setup

Resources

Lunt - 40mm Ha Solar Telescope with B600 Blocking filter - Feather Touch Focuser
$1,080

SVBONY Telescope Camera Adapter Kit Extendable Prime Focus and Variable Projection Eyepiece Connect 1.25 inches Reflector Telescope Photography
$40

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Tracking and Stacking Images

The purpose of photo stacking is to improve image resolution and signal to noise ratio. During this process, software will select the sharpest part of the image and add it to the group. Most of the unsharp parts of the image will be left out. There are many different methods of tracking and stacking photos. This is just one.

To image stars, tracking may or may not be necessary. See the chapter “Astrophotography Without Tracking.” The 500 rule will provide a quick estimate, which is 500 divided by the focal length in seconds. For example, if the focal length is 250 mm, 500 / 250 = 2 seconds, therefore the image can be tracked for 2 seconds before star trails appear. If a full frame camera is used with a lens, such as 35 mm, the calculation would be 500 / 35 mm = 14.3 seconds.

If eyepiece project is used, it is more complicated. When an eyepiece is added to the camera adapter, it increases the focal length of the telescope.
If a full frame camera is used (every 50 mm = 1x), equation would be:
For example, if telescope focal length is 360 mm and a 15 mm eyepiece is used,
500 / ((360 / 15) x 50)
500 / ((24) x 50)
500 / 1200
= 0.42 seconds to image before star trails appear, which is not much time to acquire many images.

The sun and moon move very quickly. A single image would need to be taken because the sun would be out off the screen in a matter of seconds. If multiple images are taken of the sun and moon tracking would be required. **The higher the magnification, the sturdier the setup will need to be. The slightest micro movement at high magnification even when shooting at 1/2000 of a second can cause a large enough mis-alignment of images whereby, the software will not be able to stack them. In this case, a single image may provide better results.**

The best and easiest to use mount in this author’s opinion for solar imaging would be the Sky-Watcher SolarQuest Alt-Azimuth Solar Mount. This mount has a sun detector built-in, which detects the sun and aligns the mount automatically. However, during the time of this writing, it was back ordered. The Sky-Watcher AZ-GTi Multi-Purpose Mount & Tripod was used. The AZ-GTi is actually more versatile because it can also be used to image the moon and stars.

Daytime Alignment of the Sky Watcher GTI Alt-Az Mount for Solar Observation and Imaging

Allow Solar Observing

In the Main Menu, go to Settings, then Advanced.

Toggle the “Observe Sun” switch. Two numbers will appear and a request for the sum.

Enter the sum.

Go back to the Main Menu.

Alignment

Be sure the solar filter is in place on the telescope.

Setup the mount and telescope.

Loosen the clutch on the mount.

Level the telescope

Tighten the clutch on the mount.

Loosen the screw only slightly on the bottom of the extension.

Point the telescope to North.

Tighten the screw on the bottom of the extension. Double check to see if it is level.

Go to the smartphone wifi setting.

Select Synscan wifi.

In the Synscan app, select Connect and AZ Mode or EQ Mode.

Select Alignment on the Synscan app.

Select a one star alignment. The star will not be seen during daylight in the telescope, but click ok anyway.

Click on the star in the right corner of the app.

Select “Solar”

Press the back arrow

Use the up and down and left and right controls on the Synscan app to center the sun. The number in the center indicates the slew rate. Change the slew rate using the right and left arrow keys to the left and right of the controls.

The app should automatically track the sun at this point.

Figure 5 - Sky Watcher GTi Mount and Telescope Setup

Step by Step Instructions to Process Images in Photoshop

Photoshop may not be the best software to stack images, but it is the easiest to use.

File
Scripts
Load files into Stack
Browse for images
Open all files
OK

On the right pane, select all layers

Edit
Auto Align Layers
Select Auto
OK

Edit
Auto-Blend Layers
Select Stack Images
Seamless Tones and Colors should be checked
Content Aware Fill Transparent Areas should be checked
OK

Save the final product accordingly.

Resources

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Sky-Watcher AZ-GTi Multi-Purpose Mount & Tripod
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$530
==========

4Pcs Spirit Bubble Level Mini Square Levels Bullseye Level Small leveler tool for Picture Frame Hanging RV Tripod Leveling 40x15x15MM (non-magnetic)
Mount to the telescope with double stick tape.
$11.60

Coghlan's Map Compass
Mount to the telescope with double stick tape.
$6.20

To mount a DSLR or Mirrorless camera and lens in place of a telescope, an L bracket may need to be used. It can be made from the following two parts:

NEEWER 3.15"/80mm Rail Bar Vixen Style Dovetail Plate, Metal Mounting Plate Saddle with 1/4" 3/8" D Ring Screw for Telescope Mount Adapter Base OTA Equatorial Tripod Sky Astrophotography, QR004
$29.50

PATIKIL L Bracket Tripod Quick Release Plate, Vertical Horizontal Switching Camera Tripod Adapter Mount Parts Replacement Model 2, Black
$16.50

Example

10 images stacked and enlarged 200% 1 of 10 images enlarged 200%

The above object was a stationary object as seen through a 61 mm telescope with 15 mm eyepiece projection. This image may be considered a good image. The improvement here is subtle, but can be seen clearly. Some of the grain of the roof tiles on the top of the image was brought out clearly in the stacked image. Therefore stacking can even improve a good image.

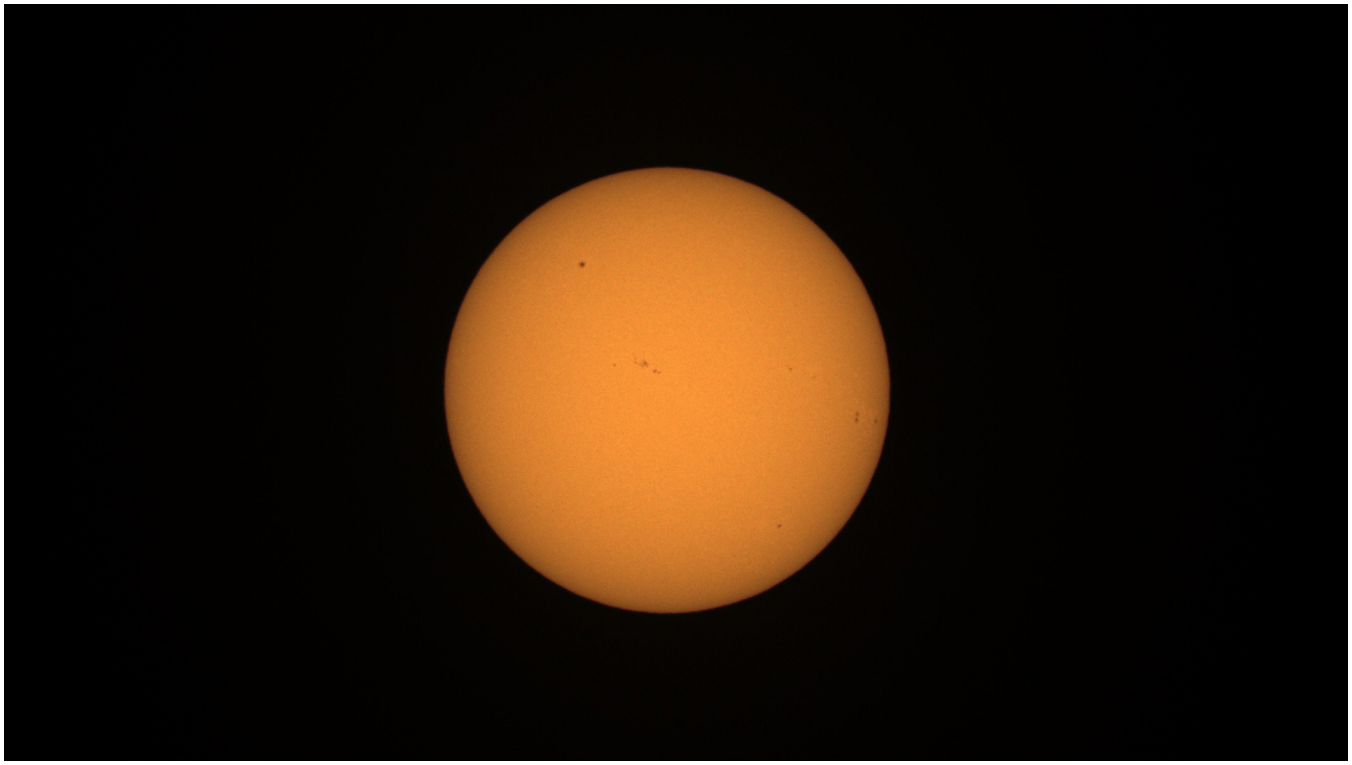
Smart Imaging Telescopes

Over the last fews years, smart imaging telescopes with built-in cameras have emerged. Smart imaging telescopes with built-in cameras and processors can be used very easily. The Vaonis Vespera is one example whereby it can be setup on a tripod and leveled. Then, the mobile phone app “Synchronicity” will do the rest.

They can obtain and stack images for long periods of time automatically. At the time of this writing, such telescopes range in price from approximately $500 to $5,000. The more expensive telescopes have larger apertures and larger sensors for higher resolution.

At the time of this writing, the Vaonis Vespera sells for $1,500. Vaonis is releasing a Vespera Pro next year with a higher resolution sensor for $2,500?. Both versions feature a 50 mm quadruplet telescope and weigh less than 10 pounds. Then, there are the usual accessories such as a solar filter, dual band filter, light pollution filter, dew sensor, larger tripod, and backpack. For solar imaging, the solar filter is essential.

Unistellar and ZWO also offer good quality smart imaging telescopes.



Vaonis Vespera 9/14/23, 4:31 pm, Northport, NY