

# Gov Aker Telescope Operators Manual



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## Governor Hunt Aker



Governor Hunt Aker was born on Dec 24, 1917. "Gov Aker" served in the Army Air Corps during World War II. After the war he became an assistant football coach at Northern Arizona University and then was a teacher and coach at Safford High School during the 1950's. He went on to become assistant superintendent of public instruction at the State capital in Phoenix. In 1964 he became the director of youth programs for the Secretary of the Interior. Later, starting in 1986 he served as the mayor of Safford and was a member of the Safford High School Scholarship and Educational Foundation. He passed away on June 30, 1993. His resting place is the Safford Cemetery.

To those that knew him Gov Aker was known for his incredible dedication and commitment to Arizona, his sense of humor, his love of golf, and his love of the people he represented.



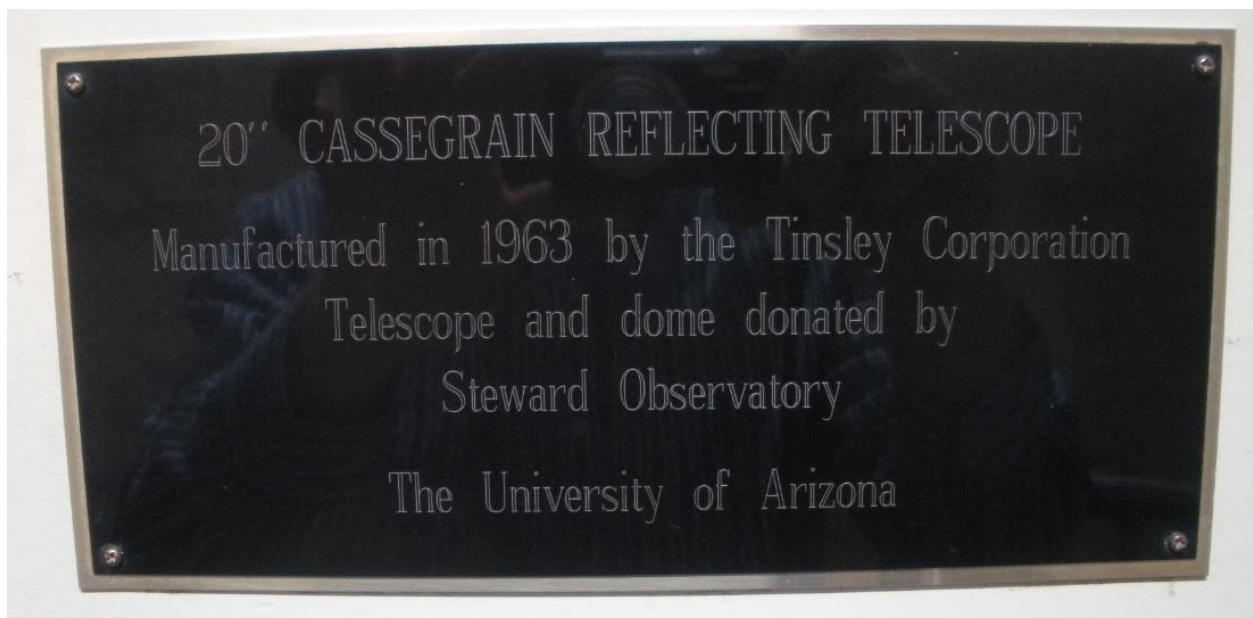
*Source: Various public records, including Congressional Record, 103<sup>rd</sup> Congress, Page S9053*

## Introduction

The Gov Aker telescope is a research-class telescope that is presently used primarily for public education. It is hoped that through this manual that the telescope enjoys a strong level of usage, as this is what benefits the telescope the most. Operators should not be hesitant to use the telescope, being mindful of a reasonable number of safety precautions that are highlighted in this manual.

This manual is intended to describe how to use the Gov Aker 20" telescope located at the Discovery Park Campus of Eastern Arizona College. In addition to describing how to use the telescope, this manual describes how to troubleshoot problems that may be encountered along the way.

Users of this manual are encouraged to provide feedback and suggestions to the MGIO Director at the email address on the front page. This manual is for the collective benefit of all Tinsley users, so all are encouraged to help in edits, corrections, and updates to this manual!



*Dedication Plaque on the Gov Aker Telescope*

## Overview

The Gov Aker telescope was manufactured by the Tinsley Telescope corporation, and is often referred to as the "Tinsley Telescope". It is a research class telescope that was previously used on Kitt Peak, and was donated by Steward Observatory, University of Arizona, for public education at Discovery Park.

The primary telescope has a 0.5-meter (20" aperture) of a classical cassegrain design. (insert optical specifications here). It provides a single corrected focal plane at the cassegrain foci.

There is also a 5" refracting telescope that is also used as a second telescope for bring objects, as a solar telescope, and a guide scope for the main 20" telescope.

The optical assembly is supplemented by a collection of small finder scopes which aid the operator in locating objects in the sky.

The telescope rides on a large equatorial mount, which allows the telescope to finely track objects with a single tracking motor. This gives the telescope the ability to follow objects for an indefinite period of time, useful for showing large number of person the same object.

The telescope is protected by a dome made by the Ash Manufacturing company of Plainfield, Illinois. The purpose of the dome is to protect the telescope from weather when not in use. The shutter is an "up and over" dual shutter design. The top shutter fully opens by riding up and over the top of the dome to create an opening for the telescope to look through. The bottom shutter is manually cranked out allowing for observation of objects located low in the sky. The dome enclosure can be ventilated by a dome ventilation fan. This is useful to pull cool night air down through the dome, particularly if the telescope is warm from the prior day. Use of the dome ventilation fan can improve the steadiness of the images viewed by the telescope.

The telescope has a collection of eyepieces, barlow lenses, filters, and other optical accessories that are used to view various objects.

The telescope has a video system which allows real-time images from the telescope to be projected by the projector in the Jupiter Room. This allows for persons to see images from the telescope without having to climb the stairs to the telescope, and facilitates lectures using real-time images of objects.

The telescope has a number of specialized instrument packages as described following.

The telescope has a Daystar Hydrogen Alpha filter system. This allows the 5" refractor telescope to be configured to show exquisite solar detail, such as prominences and flares.

The telescope has a Santa Barbara Instruments Group ST-6 CCD Imaging system which can be used for scientific-grade imagery.

## Telescope Startup

The steps to starting up the Aker telescope are detailed in the steps below. A summary of these steps is posted in the dome.

**SAFETY NOTE: It is important to follow these steps carefully each and every time, even those that are familiar with the telescope.**

**SAFETY NOTE: The telescope is very sensitive to inclement weather conditions. Do not open the dome shutters if any of the following are present:**

- High winds
- Dust
- Rain or other forms of precipitation

**It is generally accepted observatory practice that acceptable conditions must exist for a meaningful period of time (>30 minutes) before opening the dome. Rain, winds, and dust may stop momentarily, and appear to be acceptable. It is important to ensure that the good conditions are persistent before proceeding.**

1. Enter the telescope silo from the doorway at the rear of the Jupiter Room at Discovery Park. The Discovery Park staff should be contacted to schedule access for use of the telescope.
2. Turn on the light upon entering the silo then proceed up the stairwell, entering the telescope space.
3. Use a step ladder to gain access to the shutter power cord plug. Plug this into the outlet and you will hear some electrical clicks; these clicks are normal. The image below shows the shutter power cord plug and control switch:



4. Turn the switch attached to the cord so that dome top shutter begins to open. Allow the top shutter to continue to open. The top shutter will stop on its own so allow it to run until it stops.
5. Switch the dome shutter switch to the middle (neutral) position and disconnect the dome power cord. The dome will not rotate as long as the dome shutter power cord is plugged into the power socket. You will hear electrical clicks as you unplug; this is normal.
6. Move the ladder to the right of the lower door of the shutter.
7. Climb the ladder and unplug the dome ground cable. This connector is shown in the image below:



8. Hand-crank the lower shutter door to the open position. The dome shutter should be lowered where it is approximately level with the horizon; lower than this is not necessary. The crank is shown in the image below:



9. Store the ladder in a safe location.
10. Install the right-angle diagonal mirror and eyepiece at the Cassegrain focus of the 20" telescope. Connect the safety strap from the diagonal mirror to the bottom of the mirror cell. Check that all securing screws are tight. The diagonal mirror/eyepiece installed in the telescope is shown below:





11. Remove the covers from the finder scopes.
12. Install the Telrad finder if you choose to use it.
13. Open the mirror cover for the 20" telescope. **IMPORTANT!** Pull down on the bungee next to the finder scopes first, then the bungee next to the stairs. Image below shows the bungee next to the finders which is done first:



14. Turn on the power to the telescope control cabinet using the black switch at the rear (south) of the control cabinet. When you do this a red light on the opposite (north) side of the control box should come on. The first image below shows the switch and the second image shows the red light.



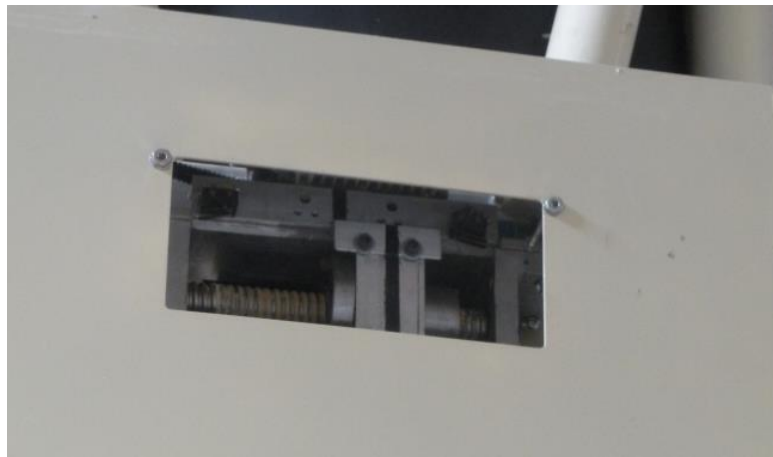


15. Verify that the Right Ascension (RA) tracking motor is on. Verify by hearing noise from the telescope, and/or check that a small LED at the top, south side of the control cabinet is lit. If the telescope is not tracking, simply press the little clear button below, and the telescope should start tracking. Confirm the little LED went out.

To reiterate look at the images below: If the LED is out, then the telescope should be tracking and you should hear noise from the telescope tracking motor. If the LED is lit, then the telescope will not be tracking. The little pushbutton switch labelled "Tracking Motor Switch" is used to toggle between these two states. So, if you find that the telescope is not tracking, this is likely the reason why.



16. Ensure that the declination tangent arm for the telescope is in the midrange of its travel. If it is not, use the hand paddle to unclamp DEC and use the North/South buttons (pick one) to drive it the appropriate direction.



17. If desired, turn on the dome ventilation by flipping on its switch.
18. At this point you are ready to operate the telescope and view objects!!

## Operating the Telescope:

To operate the telescope you must do two things:

- 1) Move the telescope to an object, and
- 2) Lock the telescope onto the object so it will track on it.

This is done as described below.

1. Verify that the telescope is operating, and the tracking system is on.
2. It is usually a good idea to rotate the dome around to the new object before moving the telescope. This way you can see the object when you are later aiming the telescope, and are not having to juggle aiming the telescope while haggling with the dome.

To rotate the dome simply use the toggle button on the hand paddle as shown in the image below:



3. Have one hand (or a person as a helper) maintain a handle on the white padded bar attached to the rear of the 20" telescope.

**SAFETY NOTE: Do not unclamp the telescope without one person maintaining a hold on the telescope at all times!**

**SAFETY NOTE: Do not allow the telescope to point downward, meaning the front end of the telescope points lower than the rear of the telescope.**

**SAFETY NOTE: The end of the declination shaft will pass very close to the guardrail at certain locations. Ensure that no-one has their hand on the guardrail in that situation.**

4. Use the hand paddle to unclamp the RA and DEC clutches. Do not try to move the telescope until the noise from both clutches has quieted, indicating that the clutches have been fully released. At this time the telescope is free to move!
5. Slowly move the telescope to aim at the new object. This may necessitate looking through finders then the main telescope.
6. Once the object is on-target, use the hand paddle switches to clamp the RA and DEC clutches. Keep the telescope steady until the clutches are fully clamped, and become quiet.
7. You can use the hand paddle to make fine adjustments in pointing once you generally have the object in view.

## Recommended Objects for Observing:

The goal of all this -- the fun part! -- is using the Tinsley telescope to show objects to the public and fellow enthusiasts! This section describes what objects are ideal to show guests for a particular night. With experience you can add more objects to your own list, so consider this to be simply the small number of showpieces that will get you off and running!

Rest assured that you do not need to be an expert astronomer to share the night sky with others. If you do not know much about an object, persons will not really mind, as objects in the night sky speak for themselves. You will have done a wonderful job simply making it possible for the telescope to be in use!

**The Moon** is without a doubt the most spectacular object to show, and it a “must see” if it is up and accessible. You can plainly tell if it is up by seeing it in the sky with your eye, and can aim the Tinsley at it with ease.



*Typical telescope view of the Moon*

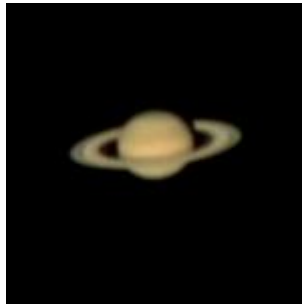
The Moon came into existence when a Mars-size planet crashed into the early Earth<sup>1</sup>. Fragments orbited the Earth and coalesced within just several weeks to become the Moon. The dark areas visible today at the moon are called Maria, from Latin “Sea”. They are meteorite craters that flooded with hot lava. Lava layers can be up to 10 km (6.2 miles) thick, higher than Mount Everest. Some facts about the Moon:

Diameter: 3 476 km (27% of Earth)  
Distance to Earth: 384 000 km (199,000 miles)  
Mass:  $7.350 \times 10^{22}$  tons (1.2% of Earth)  
Density: 3.341 g/cm<sup>3</sup> (61% of Earth)

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<sup>1</sup> Information in this section from [www.astronomysource.com](http://www.astronomysource.com)

**Saturn** is probably second only to the Moon in terms of amazement. The public are truly astounded to see the rings of Saturn, making it second to only the Moon as a spectacular object to show the public.

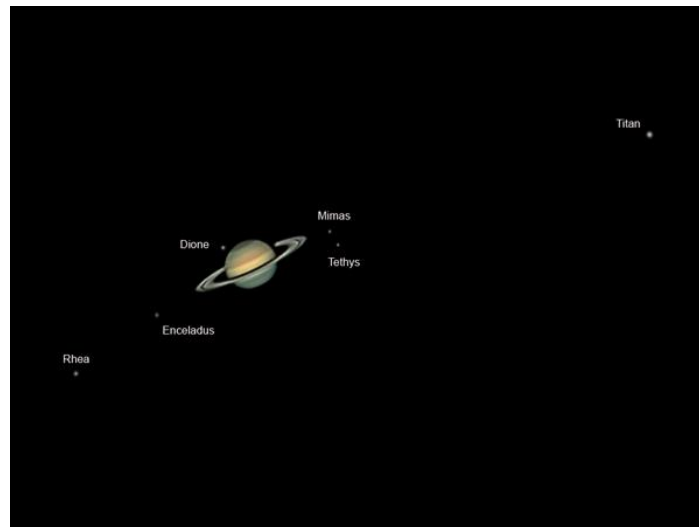


*Typical telescope view of Saturn*

Saturn is probably the most enigmatic of all planets. Its rings have given awe to many people who saw it the first time. Since Saturn is double as far from the Sun than Jupiter, it receives only a quarter of the light. While it has almost the size of Jupiter, Saturn's larger distance results in a smaller, fainter view in the eyepiece. We tend trying to compensate by increasing magnification, but this multiplies air layer disturbances as well.

With a very small telescope or under not so good seeing conditions, Saturn's rings might just be seen as "ears". In fact, this is what Galileo saw when he first looked at Saturn with his telescope. He concluded that these "ears" must be two close moons on either side of Saturn, but two years later the moons were gone, and again two years later the moons re-appeared. We know today, that the "disappearance" was caused by looking at the ring edge on but it was very confusing for Galileo at that time. With the Tinsley the "ears" are clearly seen as the rings circling the planet.

Surrounding Saturn is what appears as a collection of faint stars -- the moons of Saturn. The brightest of these is Titan, a moon comparable in size to Mercury and having an atmosphere. Image below shows a typical arrangement of the moons<sup>2</sup>.



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<sup>2</sup> Image by Stephen Roche of Waterford, Ireland.  
<http://www.astronomycameras.com/blog/archive/20080410/stephen-roche-saturn-with-its-moons/>



Titan is the only of Saturn's moons that is reasonably easy to identify. It is far brighter than all of the others. Some facts about Saturn:

Saturn is a gas giant, and has over 62 moons, with Titan and Rhea as the largest ones. Saturn has a very low density, in fact if we could build a bathtub large enough to hold Saturn, it would float on the surface.

Diameter: 123 000 km (9.4 x Earth)  
Mass:  $0.569 \times 10^{24}$  tons (95 x Earth)  
Density: 0.67 g/cm<sup>3</sup> (24% of Earth)  
Distance from Sun: 9.54 AU

**Jupiter** amazes everyone with its collection of small moons each about the size of Earth's moon, along with its belts.



*Jupiter, typical telescope view*

Jupiter is the largest planet in our solar system. It is a very bright and exciting object to observe. Four moons can be seen even with small telescopes or binoculars. The Tinsley shows Jupiter as a large and spectacular planet. If the turbulence is low and some cloud bands are visible, it might be possible to see some fine cloud details and the great red spot. Some facts about Jupiter:

Jupiter is a gas giant with over 100 moons. The four largest are Io, Europe, Ganymede, Callisto. They are also called the Galilean moons. When Galileo saw the movement of the moons he could no longer accept a geocentric model of the universe.

Diameter: 142 980 km (11.2 x Earth)  
Mass:  $1.899 \times 10^{24}$  tons (318 x Earth)  
Density: 1.32 g/cm<sup>3</sup> (24% of Earth)  
Distance from Sun: 4.95 AU

### Finding Jupiter and Saturn:

Jupiter and Saturn change locations slowly over time. They appear as very bright “stars” in the night sky. A small amount of web surfing will indicate when and if they are up. Most times you will be fortunate that at least one of the two of them will be up. The chart below indicates the constellations where Jupiter and Saturn will be for the following years. These planets appear as bright and obvious stars in these constellations:

<b>2014</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>Jupiter</b>	GEM	GEM	GEM	GEM	GEM	GEM	CNC	CNC	CNC	LEO	LEO	LEO
<b>Saturn</b>	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB
<b>2015</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>Jupiter</b>	LEO	CNC	CNC	CNC	CNC	LEO	LEO	LEO	LEO	LEO	LEO	LEO
<b>Saturn</b>	SCO	SCO	SCO	SCO	SCO	LIB	LIB	LIB	LIB	SCO	SCO	OPH
<b>2016</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>Jupiter</b>	LEO	LEO	LEO	LEO	LEO	LEO	LEO	VIR	VIR	VIR	VIR	VIR
<b>Saturn</b>	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH
<b>2017</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>Jupiter</b>	VIR	VIR	VIR	VIR	VIR	VIR	VIR	VIR	VIR	VIR	LIB	LIB
<b>Saturn</b>	OPH	OPH	SGR	SGR	SGR	OPH	OPH	OPH	OPH	OPH	OPH	SGR
<b>2018</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>Jupiter</b>	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	LIB	OPH
<b>Saturn</b>	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR
<b>2019</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>Jupiter</b>	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	OPH	SGR
<b>Saturn</b>	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR

2020	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Jupiter	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR	SGR
Saturn	SGR	SGR	SGR	CAP	CAP	CAP	SGR	SGR	SGR	SGR	SGR	SGR
2021	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Jupiter	CAP	CAP	CAP	CAP	AQR	AQR	AQR	AQR	CAP	CAP	CAP	AQR
Saturn	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP
2022	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Jupiter	AQR	AQR	AQR	PSC	PSC	PSC	CET	CET	PSC	PSC	PSC	PSC
Saturn	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP	CAP

**Mars** is often requested but rarely is a suitable object. The only exception is possibly when Mars makes a close pass of the Earth, called an **opposition**, but that is a relatively rare occurrence. Mars will appear as a bright, red “star” in the sky rising opposite of the sunset. The upcoming oppositions of Mars are:

- May 22, 2016
- July 27, 2018
- October 13, 2020

It is nice to view Mars a month or two around these above dates. Otherwise Mars will appear disappointingly small and featureless owing to its relatively small size and great distance.

As is the case with Mars, other planets are typically small and faint, and are not recommended in general.

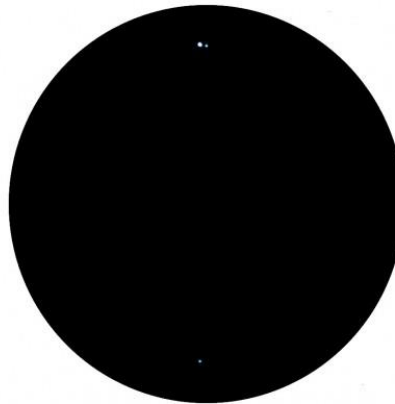
Next, there are objects such as double stars, multiple star systems, star clusters, nebula, and galaxies. These can be surprisingly large and bright. These are important particularly without the Moon, Saturn, and Jupiter present.

Following are a collection of objects suitable for the Tinsley Telescope.

**Mizar and Alcor** is the double star at the bend of the handle of the Big Dipper.



Point your telescope at the handle bend and what you see are not one but two stars. The brighter one is Mizar, the dimmer star is Alcor. They are also known as "Horse and Rider". People with good eyesight can distinguish these two stars with bare eyes. Ask the persons there to see if they can "split" these two stars with their unaided eyes! If the seeing conditions are good, choose high magnification and take a closer look at Mizar. You will see that Mizar itself has another close companion star. The image below shows an actual photo of Mizar A, it's close companion Mizar B at the top and Alcor at the bottom:



Some additional facts about Mizar and Alcor:

Constellation: Ursa Major, UMa  
Magnitude (Mizar/Alcor): 2.2 / 4.0  
Separation: 11.8'  
Distance: 83 Light years  
Mass (Mizar/Alcor): 7.7 / 2 x Sun, Diameter: 4.1 / 1.8 x Sun  
Luminosity: (Mizar/Alcor): 63 / 13 x Sun

On the next page is a list of recommended objects for each particular month. Objects that are **bold** can be observed if the moon is bright. Some of the fainter objects get washed out by the light of a bright moon, and thus should be avoided if the moon is up.

**Albireo** is the fifth brightest star in the constellation Cygnus the Swan<sup>3</sup>.



With naked eye it appears to be single star but a telescope resolves it as a double star. Both stars offer a striking color contrast. The brighter star shines in an orange/yellow color, the smaller star in blue<sup>4</sup>:



*Albireo, as seen through a telescope*

When observing colorful stars, it can be beneficial to do this somewhat out of focus. Since the star disks become larger, colors become more prominent. The reason for this is that a larger number of color receptors in the eyes can collect color information. Play with your focuser and see what works best for you! At this point it is unknown whether the stars are optical doubles or gravitationally linked and orbiting each other. The brighter star itself has a very close companion, too close though to be resolved with a telescope. Some additional facts:

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<sup>3</sup> [http://www.themcdonalds.net/richard/index.php?title=Finding\\_Albireo](http://www.themcdonalds.net/richard/index.php?title=Finding_Albireo)

<sup>4</sup> Image Credit -- Hunter Wilson

Constellation: Cygnus, CYG  
Magnitude: A 3.2, B 5.8  
Separation 35"  
Distance 390 / 390 Light years  
Mass: 5 / 3.2 x Sun  
Diameter: 16 / 2.7 x Sun  
Luminosity: 950 / 120 x Sun

**The Orion Nebula** is part of the constellation Orion. This truly beautiful nebula can be found just below Orion's belt as a part of Orion's sword<sup>5</sup>.



It is one of the brightest nebulae and is visible to the naked eye.



Because M42 is over an arc minute wide use your lowest magnification to ensure it fits in the field of view. The four stars at its center are called "Trapezium", they energize and ionize surrounding gasses which leads to this beautiful spectacle. Due to its brightness the Trapezium stars draw the observers' attention, but scanning the area around them, you will see many smaller stars and layers of ionized gas. Orion nebula is the closest region of massive star formation to the Earth. It hosts protoplanetary discs and brown dwarfs. New stars and planets are born here right now. The strong radiation emitted by the

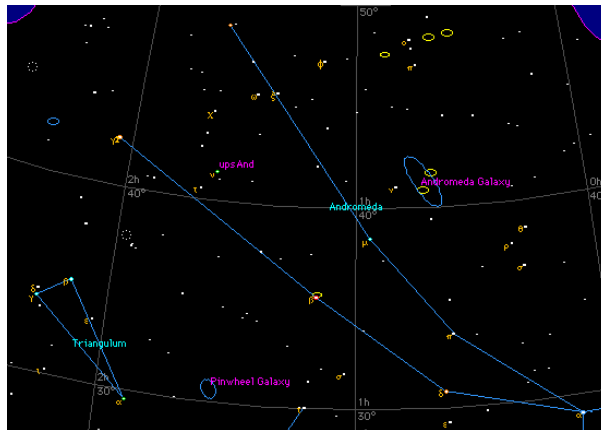
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<sup>5</sup> <http://amazing-space.stsci.edu/news/archive/2006/01/ill-01.php>

Trapezium stars is so powerful that young neighbor stars are pushed into the form of an egg. Some additional facts:

Constellation: Orion, ORI  
Magnitude: 4.0  
Size: 65'x60'  
Distance 1,344 Light Years  
Diameter: 24 Light Years  
Mass: 2,000 x Sun

**The Andromeda Galaxy** belongs to the constellation Andromeda. The constellation of Andromeda appears as a double curved line of stars that departs from the northeast angle of the Great Square of Pegasus. It is an important constellation, south of the constellation of Cassiopeia and west of the constellation of Perseus. It does not contain any first magnitude star. It can be easily found, crossing the constellation of Cassiopeia from Polar Star. In autumn, it can be seen high up in the south-east<sup>6</sup>.



The Andromeda Galaxy is the farthest object that can be seen with bare eyes.

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<sup>6</sup> Text and image courtesy of ESO. [https://www.eso.org/public/outreach/eduoff/cas/cas2002/cas-projects/france\\_andromeda\\_1/](https://www.eso.org/public/outreach/eduoff/cas/cas2002/cas-projects/france_andromeda_1/)



It is so large that it will most certainly exceed the field of the telescope view (binoculars have sufficient viewing angle), so focus on the inner core. It is a fascinating moment taking a peak at another Galaxy for the first time. The core is very bright and the surrounding areas can be seen nicely. The Andromeda Galaxy is a spiral galaxy has an estimated 1 Trillion stars (Milky Way 200 – 400 Billion). Its center comprises a massive black whole. Andromeda Galaxy and the Milky Way are moving towards each other. They will merge in about 4.5 Billion years. Some other facts:

Constellation: Andromeda, AND

Magnitude: 3.44

Distance 2.54 Million Light Years

Mass: 1- 1.5 x Milky Way Galaxy

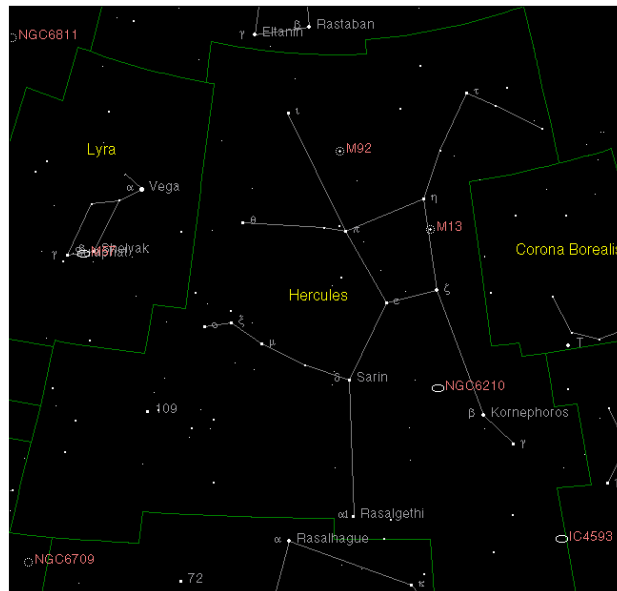
**The Hercules Globular Cluster** lies in the constellation Hercules. It is also known as “M-13” or the “M-13 Globular Cluster”. The Globular Cluster, like all globular clusters, is almost as old as the known universe and offers beautiful view even for small telescopes. In the Tinsley it is spectacular!





M-13 Telescope View<sup>7</sup>

It is a bit more challenging to find Hercules Globular Cluster. First we have to find “The Keystone”, four stars of the constellation Hercules that build a trapezoid. M13 lies on the line between Eta Herculis and Zeta Herculis. These are the two stars in “The Keystone” at the side of Arcturus. Move a little bit towards Eta on the Eta-Zeta line and you have found this beautiful globular cluster. If you have difficulties to find “The Keystone”, two bright stars, Vega and Arcturus help. Draw a line from Vega to Arcturus, “The Keystone” is located about one third the distance from Vega<sup>8</sup>.



<sup>7</sup> Santa Maria de Montmagastrell Observatory, <http://santamariaobservatory.blogspot.com/2009/09/m13-image-031-m-f49-newtonian-reflector.html>

<sup>8</sup> <http://messier.seds.org/map/Her.html>

Despite its age, Hercules Globular Cluster has not changed its form much. Pressure of star radiation pushing stars apart and gravity force pulling them together resulting in an equilibrium. The stable conditions were thought to be beneficial for possible forming of life. In 1974 a radio message was sent to the Hercules Cluster with the large Arecibo radio telescope. The digital message included information about man, earth and the solar system. Some facts about M-13:

Constellation: Hercules, HER  
Magnitude: 5.8  
Distance 25,100 Light Years  
Diameter: 168 Light years  
Mass: 600,000 times Sun  
Age: ~13 Billion years

**The Double Cluster** is one of the most spectacular sights, with two clusters of stars in close proximity. They are about 800 light years apart but due to their position in the sky, they fit both in the view of a telescope at low power<sup>9</sup>:

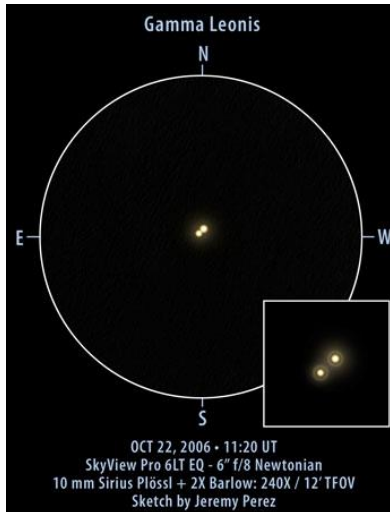


The Double Cluster belongs to the constellation Perseus. It can be easily found with the help of the constellation Cassiopeia. Just follow the inner leg of the shallow half of the “W” (Cassiopeia Gamma – Delta) about two third of the way to the next bright star, and you will find the Double Cluster.



<sup>9</sup> <http://messier.seds.org/Pics/Jpg/n0869.jpg>





Gamma Leonis-A has at least one planet orbiting it, and possibly two. On November 6, 2009, the discovery of a planetary companion around primary star Gamma-1 Leonis was announced<sup>10</sup>. The planet has an orbital period of 429 days and presumably a large mass, but less than ~9 Jupiter's. Further studies hint at a second companion as well.

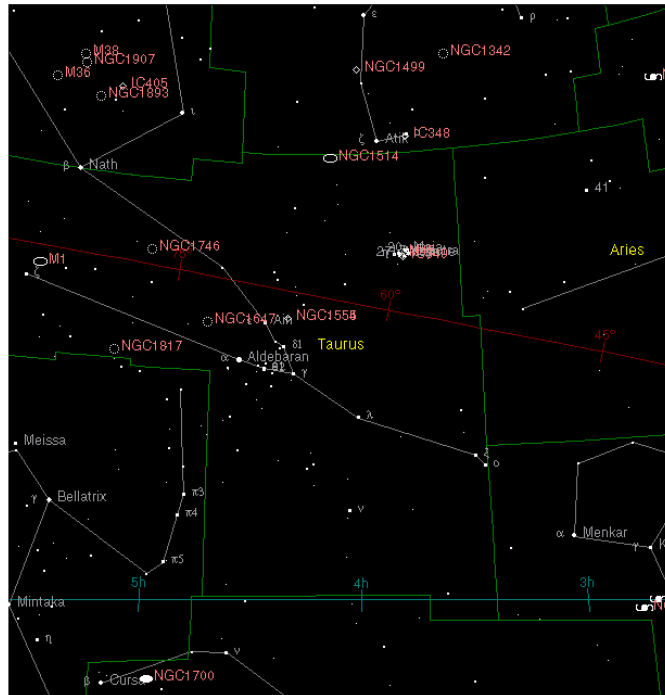
Some additional facts about Gamma Leonis:

- Constellation: Leo, LEO
- Magnitude: A 2.28, B 3.51
- Separation 4.5"
- Distance 130 / 130 Light years
- Spectral Types: A = K1; B = G7
- Mass: A = ?? B = ?? x Sun
- Diameter: A = 23 B = ?? x Sun
- Luminosity: A = 180 B = ?? x Sun

---

<sup>10</sup> "Detection of a Planetary Companion around the giant star  $\gamma$ -1 Leonis". *Astronomy and Astrophysics* 509: A24.

**The Crab Nebula** is part of the constellation Taurus the Bull. The Crab Nebula is also known as M-1. This fascinating object can be found just near the horns of Taurus the Bull as shown in the chart below<sup>11</sup>:



If you can find the Pleiades star cluster, and the neighboring “V” shaped Hyades star cluster, which contains the bright red star Aldebaran, then the Crab Nebula is in the vicinity.



*Image of the Crab Nebula*<sup>12</sup>

<sup>11</sup> <http://messier.seds.org/map/Tau.html>

<sup>12</sup> This superb image of the Crab Nebula M1 was obtained by Bobby Middleton with a 12.5-inch Newtonian on an AP1200 mount. It was exposed for 60 minutes on hypered Kodak PJ 400 film.

The Crab Nebula, Messier 1 (M1, NGC 1952), is the most famous and conspicuous known supernova remnant, the expanding cloud of gas created in the explosion of a star as supernova which was observed in the year 1054 AD. The supernova was noted on July 4, 1054 A.D. by Chinese astronomers as a new or "guest star," and was about four times brighter than Venus, or about mag -6. According to the records, it was visible in daylight for 23 days, and 653 days to the naked eye in the night sky. It was probably also recorded by Anasazi Indian artists (in present-day Arizona and New Mexico), as findings in Navajo Canyon and White Mesa (both Arizona) as well as in the Chaco Canyon National Park (New Mexico) indicate; there's a review of the research on the Chaco Canyon Anasazi art online. In addition, Ralph R. Robbins of the University of Texas has found Mimbres Indian art from New Mexico, possibly depicting the supernova.<sup>13</sup>

The nebulous remnant was discovered by John Bevis in 1731, who added it to his sky atlas, *Uranographia Britannica*. Charles Messier independently found it on August 28, 1758, when he was looking for comet Halley on its first predicted return, and first thought it was a comet. Of course, he soon recognized that it had no apparent proper motion, and cataloged it on September 12, 1758. It was the discovery of this object which caused Charles Messier to begin with the compilation of his catalog. It was also the discovery of this object, which closely resembled a comet (1758 De la Nux, C/1758 K1) in his small refracting telescope, which brought him to the idea to search for comets with telescopes. Messier acknowledged the prior, original discovery by Bevis when he learned of it in a letter of June 10, 1771.

The nebula consists of the material ejected in the supernova explosion, which has been spread over a volume approximately 10 light years in diameter, and is still expanding at the very high velocity of about 1,800 km/sec. On November 9, 1968, a pulsating radio source, the Crab Pulsar (also cataloged as NP0532, "NP" for NRAO Pulsar, or PSR 0531+21), was detected in M1 by astronomers of the Arecibo Observatory 300-meter radio telescope in Puerto Rico. It has now been established that this pulsar is a rapidly rotating neutron star: It rotates about 30 times per second! This period is very well investigated because the neutron star emits pulses in virtually every part of the electromagnetic spectrum, from a "hot spot" on its surface. The neutron star is an extremely dense object, denser than an atomic nucleus, concentrating more than one solar mass in a volume of 30 kilometers across. Its rotation is slowly decelerating by magnetic interaction with the nebula; this is now a major energy source which makes the nebula shining; as stated above, this energy source is 100,000 times more energetic than our sun.

Some additional facts:

Constellation: Taurus, TAU  
Magnitude: 8.4  
Size: 420'x290'  
Distance ~6,500 Light Years  
Diameter: ~5.5 Light Years  
Mass: ~4.6 x Sun

---

<sup>13</sup> For entire section: <http://messier.seds.org/m/m001.html>

## Calendar for Recommended Bright Objects

### January

- **Andromeda Galaxy**
- Orion Nebula

### February

- **Orion Nebula**
- Crab Nebula Supernova Remnant

### March

- **Orion Nebula**
- Crab Nebula Supernova Remnant
- **Gamma Leonis Double Star**

### April

- Orion Nebula
- **Gamma Leonis Double Star**

### May

- **Gamma Leonis Double Star**

### June

- **M-13 Globular Cluster in Hercules**

### July

- **M-13 Globular Cluster in Hercules**

### August

- **M-13 Globular Cluster in Hercules**
- **Albiero Blue and Orange Double Star in Cygnus**

### September

- **M-13 Globular Cluster in Hercules**
- **Albiero Blue and Orange Double Star in Cygnus**

### October

- **Albiero Blue and Orange Double Star in Cygnus**
- Andromeda Galaxy

### November

- Andromeda Galaxy
- **Double Cluster in Perseus/Casseiopeia (NGC 884 & NGC 869)**

### December

- Andromeda Galaxy
- **Double Cluster in Perseus/Casseiopeia**

## Telescope Shutdown

This section describes how to secure the telescope at the end of your observing session.

1. Pack and stow any observing systems such as the remove video system, solar viewing equipment, CCD imaging equipment, and other equipment. This section assumes that equipment has already been secured.
2. Turn off dome ventilation fan if it is in use.
3. Use the hand paddle to unclamp the RA and DEC clutches. Do not try to move the telescope until the noise from both clutches has quieted, indicating that the clutches have been fully released. At this time the telescope is free to move.
4. Move the telescope such that the bubble levels indicate that the telescope is pointing straight up. This is shown in the image below:



5. Use the hand paddle switches to clamp the RA and DEC clutches. Keep the telescope steady until the clutches are fully clamped, and become quiet. This will stow the telescope at zenith.
6. Remove the right angle diagonal mirror and eyepiece from the telescope and return to the storage cabinet.
7. Turn off the reticle to the finder if it has been turned on.
8. Remove and store the Telrad finder if you used it.
9. Close the mirror covers for the 20" scope, remembering to close the bungee nearest the stairs first, and the bungee closest to the finders last.



10. Rotate the dome to the north. The yellow arrow on the dome should point approximately to a black stripe on the dome wall, as shown in the image below.



11. Move a ladder adjacent to the lower shutter hand crank.
12. Climb the ladder and hand crank the lower shutter closed. Be sure to close the bottom shutter before the top shutter is closed!
13. Connect the ground conductors for the dome, as shown in the image below:



14. Plug the shutter motor power and close the top shutter. It will stop automatically.
15. Turn off power to the telescope control cabinet; switch on the south side of the control cabinet.  
Confirm the light on the north side of the cabinet goes out.
16. Make one last check that all seems put away and as you found it.
17. Turn off the lights as you exit the silo and enter the Jupiter Room.

## Remote Video System

The telescope has a video system which allows real-time images from the telescope to be projected by the projector in the Jupiter Room. This allows for persons to see images from the telescope without having to climb the stairs to the telescope, and facilitates lectures with real-time images of objects.

The remote video camera is an Astro-Video Systems MK III. A complete manual for the camera is included as Appendix A of this Operators Manual.

This section describes the use of this video capability.

### Startup of Video System:

1. The video system is stored in a small case as shown in the image below:



2. In the case find the small focal reducer and attach it to the video camera. The focal reducer and it attached to the camera are shown in the images below:



3. If you are installing the video camera on the 20" telescope, you will need to use the 2" to 1-1/4" adapter, shown in the image below. This is also kept in the video camera box.



4. Insert the camera fully into the telescope and tighten the setscrews snugly such that the camera cannot fall out of the telescope.



5. Find the camera controller and plug it into the camera. The plug attaches to the camera in only one way; shown in the image below:



6. Find a cable umbilical near the desk; consisting of a video cable and a power cable; two cables total.
7. Plug the power cable into the back of the camera; image below:





8. Plug the video cable into the back of the camera; image below:



9. Turn on the Radio Shack 3-amp power supply using the switch as shown in the image below:



10. Use the TV remote to turn on the TV:



11. There are two active channels on the TV. The up/down channel buttons on the remote are used to cycle between two channels. These channels are:

- Channel 68 -- this is the video feed from the telescope.
- Channel 64 -- this is video from a camera in the Jupiter Room.

The idea is that Channel 64 will allow you to see the presentation in the Jupiter Room while setting up the observatory, and also allow you to monitor that the video from the telescope is properly projecting on the screen down there. Channel 68 is video from the telescope video camera; objects being viewed through the telescope. You can see these objects on the monitor while they are also being projected down in the Jupiter Room. Channel 68 is the only video that shows on the Jupiter Room screen.

12. To activate the projection of objects in the Jupiter Room the projector in the Jupiter Room must be tuned on, and use the “Video” button” on the remote to cycle to the video channel, finding the video from the telescope. This is shown in the image below:



13. Next point the telescope at an object. The first goal is to achieve a good focus on the object. Rotate the focuser knob slowly as needed to improve the focuser until it is optimum.
  
14. You can adjust the exposure of the video camera depending on whether it is a bright object (Moon, planets) or faint objects (nebulae, galaxies). For fainter objects it is highly recommended to install the video camera on the 20" telescope. Use the camera handpaddle to adjust the exposure speed as follows:
  - a. Exposure → Lens → Speed
  - b. Under "Speed" you can try "Auto" and the camera might be able to automatically adjust to an acceptable level of image brightness. If not, manually select exposure durations.



## Daystar Filter System

The daystar filter system is used with the 5" refracting telescope to provide narrowband views of the Sun. This allows for exquisite observations of prominences, flares, and other solar details.

A full manual of the Day Star Solar Filter system is attached to this manual as Appendix B.

The Gov Aker Daystar has the following model information and properties:

Model: ATM  
Serial #: A-796  
Central Wavelength: 6562.8Å  
HW (Bandpass Width): 0.6Å  
Power: 12W, 115V  
Operating Temp: 48C

The Daystar filter system comes with two primary components as described below:

1. Energy Rejection Filter: The energy rejection filter is installed onto the top of the 5" refractor. This filter is intended to reject much of the solar energy from entering the system.



2. Narrowband Filter Body: The narrowband filter assembly is installed into the focuser of the 5" refractor. This assembly has a heater which precisely heats an interference filter such that only one specific wavelength of the Sun's light gets through the telescope.



### **Solar Observing with the Daystar Filter System:**

**SAFETY NOTE:** The steps to use the Gov Aker telescope for solar observing are very different than for night-time observing. It is imperative that the steps be followed as described for solar observing as they are different than for dark-time observing.

**SAFETY NOTE:** It is important to follow these steps carefully each and every time, even those that are familiar with the telescope.

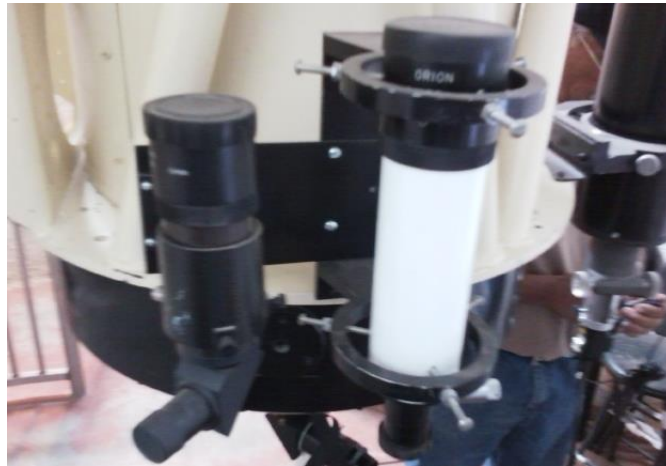
**SAFETY NOTE:** The telescope is very sensitive to inclement weather conditions. Do not open the dome shutters if any of the following are present:

- High winds
- Dust
- Rain or other forms of precipitation

**It is generally accepted observatory practice that acceptable conditions must exist for a meaningful period of time (>30 minutes) before opening the dome. Rain, winds, and dust may stop momentarily, and appear to be acceptable. It is important to ensure that the good conditions are persistent before proceeding.**

1. The person observing with the Daystar needs to be an experienced user of the Gov Aker telescope and be completely familiar with the steps to startup, operate, and shutdown the telescope.
2. Enter the telescope silo from the doorway at the rear of the Jupiter Room at Discovery Park. The Discovery Park staff should be contacted to schedule access for use of the telescope.
3. Turn on the light upon entering the silo then proceed up the stairwell, entering the telescope space.
4. DO NOT do anything with the dome or dome shutters! The goal of the next several steps is to configure the telescope for solar observing prior to opening the dome.

5. Ensure the 20" telescope is safe. The 20" will not be used for solar observing; only the 5". Ensure that the 20" eyepiece is NOT installed, and that the mirror covers for the 20" are closed.
6. Verify that the Telrad finder is not installed, that the other finders have their covers installed. Light from the Sun WILL damage any finders that are not covered and become exposed to sunlight. In the image below note that the lens covers for the two finders are installed.



In the image below note that the Telrad is not installed. The EZ Finder II still needs to be removed to ensure the Sunlight does not damage it.



7. Confirm that the telescope is at its normal park position (i.e., pointing straight up), where the bubble levels are nominally as shown below:
8. Turn on the control power

9. Use the hand paddle to unlock only the declination axis. Keep a hold of the telescope.
10. Move the telescope in declination until the telescope is tipped at about 45-degrees. This is so you can access the top of the 5" refractor.
11. Use the hand paddle to re-clamp the declination axis.
12. Position a stepladder to allow safe access to the top of the 5" refractor.
13. Install the energy rejection filter onto the top of the 5" refractor. It screws on in a clockwise fashion from the perspective of looking down on the filter from the sky. Take care not to cross-thread the delicate threads. A good technique is to lightly place the filter onto the top, rotate the filter as if unscrewing until it clicks down when the threads engage. Then proceed to screw the filter into place until it is snug.

**SAFETY NOTE: It is imperative to ensure that the energy rejection filter is securely attached to the top end of the 5" telescope!**

14. Install the narrowband filter body into the focuser of the telescope as shown in the image below:



15. Leave the filter regulator at its present setting -- do not adjust!!

**SAFETY NOTE: Do not exceed the suggested peak setting of 9.0 under any circumstance or permanent damage to the filter may occur.**

16. Plug the power cord of the filter body into AC power. There is a yellow extension cord to help get to an outlet. Keep tabs on time as it will require approximately **one hour** for the filter to reach operating temperature.
17. While waiting for the filter to heat up, proceed to open the dome shutter, rotate the dome, and point the telescope at the Sun.
18. As the filter reaches operating temperature prominences and details on the chromosphere should become visible. At this point, as needed the dial can be adjusted *slightly* to improve the contrast. Make a **small** adjustment, and then allow sufficient time to pass to judge whether the change was in the correct direction.

# **Appendix A**

**Manual for**

**Astro-Video Systems  
MK III Video Camera**

## **ASTRO-VIDEO SYSTEMS**

# **ADVANCED CAMERA MK II and MK III OPERATING INSTRUCTIONS**

Copyright Astro-Video Systems , December 4th<sup>th</sup> , 2013  
v1.1 , 12.05.2013



ASTRO-VIDEO SYSTEMS  
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Lake Worth , FL 33467

<http://www.astro-video.com/>  
email: [mattflastro@gmail.com](mailto:mattflastro@gmail.com)

Users Support Group: <http://tech.groups.yahoo.com/group/astro-video>

**Note:** This equipment has been tested and found to comply with the limits for a **Class B** digital device pursuant to **Part 15** of the **FCC Rules**. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the receiver and the equipment.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.
- Shielded I/O cables to be used when operating this equipment.
- You are also warned, that any changes to this certified device will void your legal right to operate it.



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## 1. Introduction

Congratulations and thank you for buying an Astro-Video Systems Advanced Camera model .

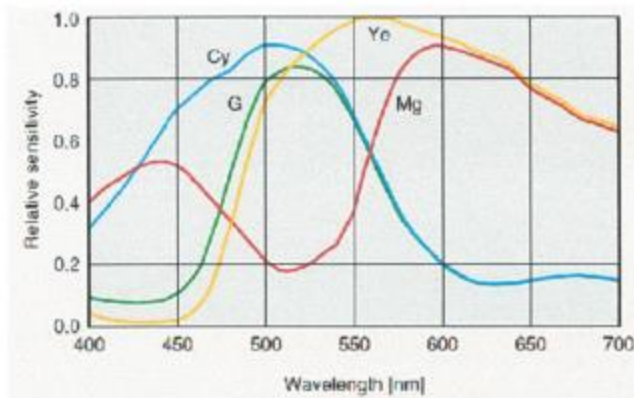
This camera has the following features and specifications :

- it is equipped with a 1/3" state of the art Sony 2<sup>nd</sup> generation SuperHAD II CCD sensor of the highest sensitivity available today in any video camera .

- its sensitivity is rated by Sony at 2450mV , DOUBLE that of the old gen 1 sensors that were rated at 1200-1400mV ( the older 1/2" size ceramic package sensors used in other vendors cameras such as Mintron, Gstar, Mallincam , Stellacam ) .

- YCMG complementary color filters matrix for maximum light transmission.

- extremely high sensitivity extending into near-IR , well past Hydrogen-Alpha spectral lines .



Left image shows relative spectral response of gen 2 SuperHAD CCD sensors as published by Sony .

- AMP-GLOW ELIMINATION circuit - this is NOT a digital processing gimmick. It does not work by digitally subtracting the amp glow signal after the fact to present an artificially uniform background of reduced dynamic range.

This unique circuit simply drives the CCD sensor in a different mode than all other video cameras (because other video cameras are based on surveillance camera processors) .

This new CCD drive mode simply DOES NOT GENERATE amp glow from the source , instead of trying to remove it later .

- lowest power design, generates lowest amount of self-heating .

- processor based thermal management with internal temperature sensor .

- 9-14.5VDC operating voltage , ONLY 120mA max current draw . A modest 7Ah 12VDC battery pack would power the camera plus remote for 56 hours !

## 2. **Knowing Your Camera Parts**

Included with your camera are the following accessories :

- Astro-Video Systems Advanced Camera body

- 1.25" to C-mount adapter nosepiece

- 5mm C-mount spacer ring

- camera to remote handbox cable. This cable fits only one way .

The remote cable to camera 4 pin connector is keyed and it too only fits the right way.

The remote cable to remote handbox connector is a 3.5mm coax plug.

Please make sure this is plugged into the remote all the way , otherwise the remote will not power up.

- 12V car lighter adapter with red LED power indicator

- 20ft siamese video and power cable . The camera end of this cable has a male power plug , while the opposite end has a female jack (both 5.5mm with 2.1mm ).

The power connection is center positive. There is a BNC to RCA adapter in case your monitor does not use BNC for composite video in .

- remote handbox



If any of the components in the left picture are missing , please contact Astro-Video Systems .

**IMPORTANT :DO NOT ATTEMPT TO DISASSEMBLE THE CAMERA. THERE ARE NO USER SERVICEABLE PARTS INSIDE . ANY ATTEMPT TO MODIFY OR DISASSEMBLE THE CAMERA OR REMOTE WILL VOID THE WARRANTY .**

### 3. **Getting Started**

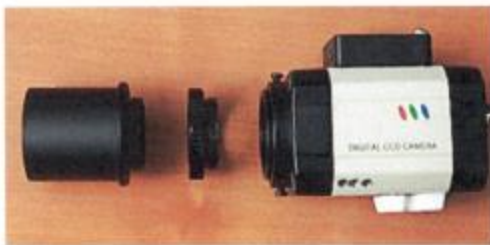
If you're familiar with video astronomy cameras , you can set up and start using this camera right out of the box.

REMOVE CAP:



Start by removing the cap off the camera C-mount .

ATTACH NOSEPIECE AND IF NEEDED 5MM SPACER:



The camera has a standard CS-mount with a mount flange to sensor 12.5mm distance.

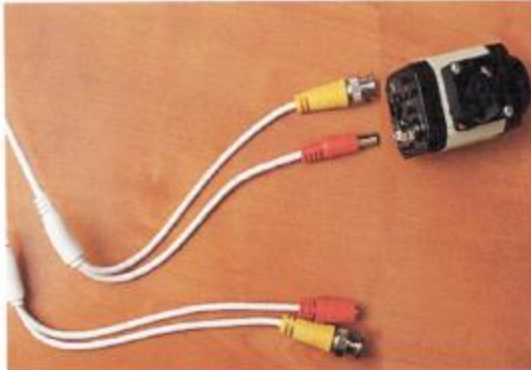
If this distance is too small, it can be increased by adding spacers . Your camera was shipped with one 5mm C-mount spacer .



This is what the camera, 5mm ring and 1.25" nosepiece should look like when assembled correctly.



## CONNECT POWER:



The power cable ends are NOT identical, one is male and plugs into the camera, the other is female and you plug the included 12V car lighter adapter into it (or a user supplied 12VDC source).



## CONNECT BNC VIDEO AND REMOTE CABLES TO CAMERA:



Connect the BNC video cable to the camera and the other end to your monitor or video capture device .

If your monitor or video capture device uses an RCA style connector, use the included BNC to RCA short metal adapter as shown in above image .

#### 4. **Basic Connection - NO REMOTE**

A basic connection is achieved by plugging in only the video and power with no remote or computer connections, just as shown in the previous page image.

This has the advantage of a very simple and quick setup but has the disadvantage of being forced to use the camera OSD keys for any adjustments.

Please note that in this configuration only the OSD menu functions are available.

**IMPORTANT :** Manual gain control is **NOT** available since there is no remote to control it. Without the remote , camera gain defaults to 0 (lowest value) .

**In this configuration the camera is 200 times LESS sensitive than WITH the remote .**

Manual **BLACK LEVEL** adjustment is also not available without the remote handbook . The camera will default to a mid black level at power up.

All other previously set menu options will be initialized with the values that were in effect when the camera was powered down, **EXCEPT** for white balance .

At power up, the camera will readjust the white balance for all settings **EXCEPT MANUAL**.

The camera only preserves **MANUAL WHITE BALANCE** settings thru power on/off cycles .

Plug the 12V car adapter into your 12VDC power source (battery or AC/DC adapter) , switch on the monitor and you are ready to start viewing .



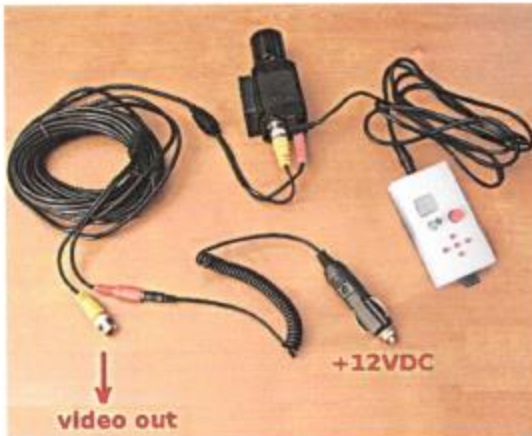
Your basic cable configuration should look like in the left image .

## 5. Stand-Alone Remote Connection

**NOTE: VERY IMPORTANT - Go to SYSTEM Menu and set CAMERA ID to 1 .  
Set Baud rate to 38.4kbps or 38400 . The remote keys and computer control  
will not work with any other settings . Manual gain control is not affected.**

A standalone remote setup consists of the camera with the power, video and remote cables plus the remote handbox connected , but no computer connection.

In this configuration, all camera functions are accessible from the remote , the manual gain , black level adjustment , O.S.D. menu keys and image freeze on/off .



This image shows a standalone remote configuration connection . This configuration applies to MK II and MK III cameras. The remote in the image is a MK II model .



A 2-digit red LED display is situated on the remote right above the illuminated MANUAL GAIN CONTROL rotary knob .

A FREEZE IMAGE button is to the right of the manual gain control .

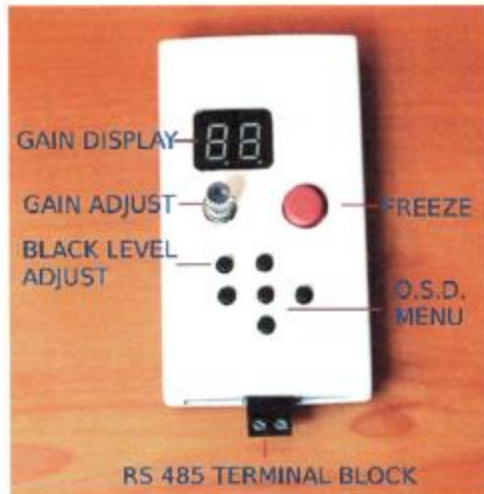
A BLACK LEVEL manual adjustment key is right below the gain control knob ( MK III only) .

A detailed description of the remote and how to use its functions follows on next page .



## 6. MK II/III Remote Handbox

The MK III remote handbox is pictured below.



- GAIN DISPLAY - indicates camera gain value from a minimum of 00 to the maximum available of 63 .
- GAIN ADJUST - rotary knob used to increase/decrease gain .
- FREEZE - momentary key press toggles image freeze ON/OFF .
- BLACK LEVEL ADJUST - steps black level thru 8 successively brighter steps , from darkest to brightest . ATTENTION - this modifies only the black level , NOT overall image brightness . MK II does not have the black level adjustment.

At power up the camera will start with a default low to medium gain and a medium black level .

The remote gain display should read “16” in a dim red color .

If you're doing daytime terrestrial or solar observations, press and hold the red FREEZE IMAGE key on the remote down while you power up.

The camera will start with a daytime default lower gain of “06” and the remote display will be much brighter in order to be visible outdoors during daytime.



Left image shows night time dim display, right side of image shows daytime brightness.

In both cases , after power up the user can still adjust gain to any desired value , the difference between the daytime and nighttime settings is the startup gain value and the display brightness .

Display brightness can only be changed at power up, in order to avoid being switched to bright accidentally during night observations .

The camera powers up at a default medium black level value, halfway between the darkest and brightest background values.

The first black level key press adjusts the black level to get the darkest background . **This does NOT affect the white level** . Each subsequent black level key press steps to successively brighter black levels , for a number of 8 black level steps, after which the cycle repeats (MK III only).



The white level brightness is adjusted independently of the manual gain control (both the remote gain knob and the software BRIGHTNESS slider perform this function and can be used simultaneously).

NOTES :

- The remote handbox allows simultaneous use of the rotary gain control AND menu keys. The user may freely adjust the gain at any time, whether the O.S.D. menu is open or not .

While in the O.S.D. menu you can just turn the gain knob and see the results on screen immediately, without interrupting any menu operation .

The handbox gain control knob, the computer software GAIN slider and O.S.D. menu can all be used simultaneously. For example the user may adjust gain from the handbox, open the menu from the computer software, navigate thru the menu using any combination of the handbox menu keys and the software menu keys .

- The CAMERA allows internally a continuous black level adjustment with a range of 0 to 255 in one unit increments .

MK III ONLY:

In order to not add too much complexity to the hand remote , the remote black level key only steps thru the 8 black level values .

The PC software generates the whole range from 0 to 255 with a step of one unit .

When the camera is connected to a PC and controlled via software , black level can be adjusted both from the remote and from the PC software .

The remote will always step only thru the 8 steps and the PC always allows continuous adjustment.

Black level control from the remote handbox and PC can be mixed , for example the user can slide the PC software BRIGHTNESS slider to set any desired black level value , after which press the hand remote black level key to step to the next remote generated value.

**Do not confuse the camera O.S.D. Exposure menu BRIGHTNESS adjustment with the PC control software BRIGHTNESS adjustment.**

The Exposure menu BRIGHTNESS sets the camera OUTPUT black level .

The computer software BRIGHTNESS adjustment , same as the remote black level key, adjust the black level AT THE CAMERA INPUT ( CCD analog reading) and is THE FIRST that needs to be optimised .

Without a correct input signal, a correct output is NOT possible.

## 7. Remote Computer Control

The remote handbox contains the necessary circuitry in order to allow computer control of the camera.

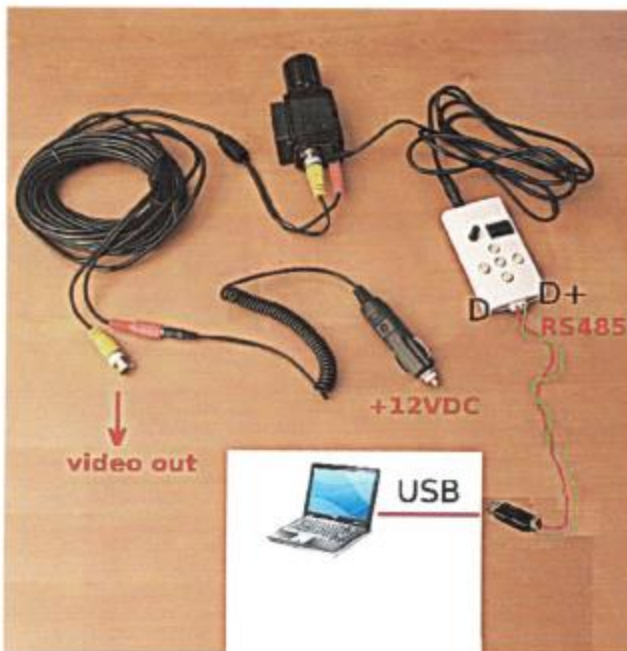
Use the supplied USB to RS485 adapter as shown below.

Connect any twisted wire pair to the USB to RS485 dongle noting the D+ and D- signals. Wire length can be up to 1000 ft .



Please note that RS485 control will not work if the wires are reversed (D+ wire connected to the D- screw terminal instead of D+ screw terminal ).

Connect the D+ and D- wires to the remote screw terminal block as in the photo below.



Install the USB to RS485 drivers downloaded from the Yahoo group FILES section .

Install the camera control software . Now you can control your camera remotely from your computer.

**NOTE:** computer control is only possible THRU the remote handbox as described . Do not attempt any other type of connection to control the camera .DO NOT attempt to bypass the remote handbox or use other remote to camera cables than the one supplied with the camera . Any other type of connection to control the camera is not possible , will not work and will damage the camera and void the warranty .

## 8. OSD Menu Operation



Pressing the center key on the remote, camera back or computer control software opens the on screen O.S.D. menu top level , as shown in the picture to the left.

The LEFT/RIGHT keys are used to scroll horizontally thru the top menu icons.



Press the center key again and it opens the submenu for the icon that was highlighted in blue.

The leftmost is the EXPOSURE submenu .

Select NORMAL exposure using the L/R keys for all operating modes except for :

- very high dynamic range situations such as lunar viewing , when WDR can be used
- for synthetic coronagraph use HLI mode .



**NOTE :** Normal mode is linear . HLI, BLC, WDR are NOT linear and stretch the histogram based on different curves



### SENSE-UP must be set to OFF

This is an automatic sense-up in which the camera attempts to set integration time based on an average scene illumination . It works on terrestrial targets but does not work on night time astronomical targets due to the large difference between the average scene illumination and target illumination.

**AGC must be OFF unless IN CAMERA FRAME STACKING IS USED** for stacking up to 5 frames = 85 sec /100sec integration (NTSC/PAL ).





AGC must be set to OFF for normal viewing.  
 AGC must be set to LOW ONLY for 3D Noise Reduction. The 3D noise reduction will not operate unless AGC is set to LOW.

3D Noise Reduction "STACKS" up to 5 successive image frames in-camera.

NOTE: DUE TO STACKING IT WILL TAKE A FEW INTEGRATION CYCLES TO SEE A FINAL IMAGE IN 3D NOISE REDUCTION MODE.



### 9. Adjusting Integration Time

Scroll down to LENS and select ELECTRIC, then press the center key again to enter this sub-menu.



Once in the ELECTRIC sub-submenu, scroll left and right to find the exposure time you need. Available values are from the longest single frame integration of x1024 cycles (17sec) to the shortest value of 1/100,000 sec (that is 10 microseconds).



When changing integration time, especially from long integration to shorter values, you may inadvertently trigger the CCD protection mode, which shows as a white screen. When this occurs, scroll thru integration SPEED values to shorter values, all the way past AUTO, to 1/100 - 1/250 and then back to AUTO and x8. The white screen disappears. Return, then SAVE&EXIT.



## 10. Adjusting Manual Gain and AGC

The only way to adjust manual gain is via the remote handbox or computer software . The manual gain stays fixed at the value you selected, until you change it. The camera DSP NEVER changes the manual gain value.

The manual gain is a real physical amplifier that exists in the camera, immediately after the CCD . It reads the CCD output at the gain you selected via the manual gain adjustment.

The Automatic Gain Control is a DSP processing gain . It is the result of calculations performed by the camera's internal computer by adding and “stacking” successive image frames and then simply scaling the result . It is useful when 3D noise reduction from the ENHANCEMENTS menu is used, because that is the only time stacking several frames is performed in the camera.

AGC should be always set to OFF for single frame integration .

AGC should be only set to LOW when using in camera stacking . No other AGC settings are recommended.

## 11. Manual Gain vs. Integration Settings

Changing the manual gain readout by 9 counts has approximately the same effect on image brightness as changing the integration time by a factor of 2 .

The following combinations of integration and manual gain readout are producing about the same image brightness: x1024 and 13 , x512 and 23 , x256 and 33 etc.

The following integration and gain combinations are 2 full f-stops faster than the above: x1024 and 33 , x512 and 43 , x256 and 53 etc.

However, image noise increases more rapidly with increasing gain than with increasing integration time.

It is recommended to use the high gain + short integration settings for finding targets and for focusing (in conjunction with digital zoom from the EFFECTS menu), then switch to longer integration (with or without in camera up to 5 FRAME STACKING 3D-DNR) for detailed viewing noise free images .

**IMPORTANT FOR ALL MENU OPERATIONS: AFTER A SELECTION IS MADE , IT IS SAVED ONLY IF YOU SCROLL DOWN TO EXIT (DO NOT EXIT) AND THEN TO THE RIGHT , TO “SAVE&EXIT” . IF YOU SCROLL ONLY DOWN AND EXIT ,THE CAMERA SIMPLY DISCARDS YOUR SETTING CHANGES. SELECT “SAVE&EXIT” AND PRESS SELECT (THE CENTER KEY) .**



## 12. Adjusting Color Balance

The Color Balance menu has several automatic modes, one push to measure and hold mode and a fully manual mode.



Manual mode is a good start because it is the only mode in which you can see and adjust the exact color balance you want.

All other modes rely on the camera to measure something, without user control.

Manual mode relies on your input only. **MANUAL is the ONLY WB mode that is saved thru a power off/on cycle.**



In manual mode you adjust the gain for the colors RED and BLUE. A good starting point is around the values shown in the left image.

Color balance changes when filters are used.



The camera must be set to DAY to observe in color. The camera must be set to NIGHT if no color (B&W only) operation is desired.

DO NOT set to AUTO mode because the results are unpredictable and the camera would randomly switch back and forth between color and B&W.





Under the EFFECT menu you can FREEZE/UNFREEZE the image but this function is performed a lot simpler by using the hand remote FREEZE key.

The MIRROR function allows mirroring along one or both axes in any combination .

### 13. Using Digital Zoom



The DIGITAL ZOOM can be used for focusing on a star and temporarily zooming in at any power from x1.0 to x10.0 in small increments.

The digital image stabilizer and digital zoom are mutually exclusive .

Most efficient use of digital zoom is to set zoom level to a desirable value and only switch zoom on and off , leaving zoom level unchanged .

### 14. Adjusting Sharpness



A sharpness value of 10 is a good starting point . Lower values will give a softer image . Higher values might show more detail but there is a point past which sharpening artifacts become obvious in the form of black halos around bright stars . Higher sharpness values might also increase noise levels .

### 15. Adjusting Gamma



The GAMMA setting can be adjusted from 0.3 to 1.0 . A value of 0.3 brings up the most details from dark image areas .

IF you use a LCD monitor, set the MONITOR to LCD ,not CRT ( in the ENHANCE menu).

DPC must be set to AUTO in order for the camera to eliminate or reduce hot pixels .

The DPC effect will occur only after at least 3 integration cycles have elapsed since DPC was set .

## 16. Compensating for Vignetting



Scroll down to LENS CORR.  
Using the LEFT/RIGHT keys increase or decrease the amount of vignetting compensation that is applied.

A value of 0 means no compensation applied. Vignetting compensation is applied in the form of variable gain which increases radially starting from the lowest gain value in the image center. Its function is to apply a flat field correction on

the fly (in real time).

## 17. 85 sec In-Camera Stacking, 3D Noise Reduction , DPC

At higher temperature any CCD will generate more noise . Approximately a 6 degree increase in sensor temperature doubles the amount of noise .

The camera processor is capable of eliminating noise by in camera stacking up to 5 successive frames.

The number of successive frames that are stacked is adjusted by selecting the 3D-DNR intensity in the range from 0 to 5.

0 means NO 3D-DNR is applied, 5 is the maximum. A setting of 5 means the camera stacks 5 successive frames . Please use this setting with the understanding that it will extend the integration time considerably. Stacking 5 frames of 17 sec each means a total integration time of  $5 \times 17 = 85$  sec (NTSC) to  $5 \times 20 = 100$  sec (PAL) .

This represents a total integration time of around 1 min and 1/2 and is a very powerful integration tool but increases the demands on mount tracking , guiding and polar alignment.

NOTE: the GAIN applied to the 3D-DNR process is set in the EXP menu by the AGC setting. AGC must be set to LOW for in camera frame stacking .

When AGC is set to OFF in EXP menu, the 3D-DNR IS SWITCHED OFF.

3D-DNR is based on stacking successive frames and as such, you need to be patient and allow the time for the camera to stack the number of frames.

No camera could stack 85 sec total exposures in 20 seconds or in any other amount of time shorter than 85sec !

The DPC function automatically removes hot pixels by digitally subtracting them. It only has 2 settings, OFF and AUTO. There are no user parameters to adjust.

DPC also needs several successive frames to operate. As such, it will take several integration cycles to complete after the function is turned on OR AFTER INTEGRATION TIME WAS CHANGED , before hot pixels are removed.



## 18. System Settings and RS232/485 Communications



The camera must always have COMM ID = 1 even if not used with computer control.

Any other COMM ID setting will result in the camera ignoring all further commands from remote or computer .

The BAUDRATE must always be set to 38400 .

Any other BAUDRATE setting will result in the camera ignoring all further commands from remote or computer , with the exception of MANUAL GAIN and BLACK LEVEL which will continue to operate .

TITLE can be switched on in order to overlay any user entered text .

**WARNING: DO NOT RESET CAMERA TO FACTORY SETTINGS FROM THE "EXIT" MENU. ALL YOUR CURRENT SETTINGS WILL BE LOST. THE CAMERA WILL DEFAULT TO A CHINESE MENU AS SHOWN BELOW.**

### How to Exit the Chinese Menu and Restore Language Setting



Press the center SELECT key on the camera rear panel or on the remote .

Your screen will display a menu similar to the image on the left.

Using the LEFT/RIGHT keys, move the blue highlight to the icon showed in the photo .

Press the SELECT center key.

This opens the SYSTEM menu in Chinese as shown. Use ONLY the DOWN key to scroll down to 5<sup>th</sup> position from top (from CAMERA ID incl) .

Use now the LEFT/RIGHT keys to scroll thru the language selection. You will see the menu language changes as you scroll left/right.

After you made your selection (you should now see English) , scroll down to EXIT but DO NOT EXIT!

Scroll RIGHT/LEFT until you reach SAVE&EXIT and select it , then press the center key. Only now your selection is saved, if you exit without the SAVE&EXIT the camera will default to its previous settings .

## 19. Specifications

Camera type	- composite video NTSC or PAL (must be selected when ordering)
Sensor	- ICX810AKA/811AKA (NTSC/PAL) SONY SuperHAD II CCD
sensitivity	- 2400mV (Sony method 1 - 706cd/m <sup>2</sup> , 3200K, CM500s , F5.6 )
Color filters	- complementary YCMG (yellow cyan magenta and green)
CCD size	- 1/3" size ( 6mm diagonal ) , 5.58mm*4.67mm
pixel size	- 5.0 um (H) * 7.4 um (V)
CCD defects	- CCD class 1 or better
Exposure time:	
SHUTTER:	- 1/100,000 sec (10microseconds) , 1/10,000 , 1/4,000 , 1/2,000 1/1,000 , 1/500 , 1/250 , 1/120 , 1/100 , 1/60
LONG EXPOSURE	- x2 to x1024 (17sec) in single frame mode , max 85sec/100sec (NTSC/PAL) in3D-DNR internal frame stacking mode
FRAME STACKING in camera up to 85 sec NTSC/ 100sec PAL	- in camera user adjustable 0 to 5 frames : max 17sec x 5 = 85 sec (NTSC) max 20sec x 5 = 100sec (PAL)
Gain	- HIGHEST GAIN with NO AMP-GLOW EXCLUSIVE CIRCUITRY - no other camera on the market has this circuit
Operating temp	- between -30 C to +60 C (Sony does not specify ANY type CCD plastic, ceramic or scientific sensor above +60C )
Dimensions	- CS-mount , 12.5mm sensor distance , size 65mm*42mm*42mm
Video output	- BNC connector 75 Ohm , NTSC/PAL composite video
Video Standard	- NTSC or PAL must be selected at moment of purchase . It can NOT be changed later.
Power connector	- 5.5mm plug , 2.1mm center positive
Power	- +9VDC to +14VDC
Current	- less than 0.12A including remote (with fan running). Use at least 250mA adapter , 500mA to 1A recommended
INTEGRATION:	- under 0.1A for frame integration long exposures (incl stacking)
Cooling	- temperature sensor , processor controlled variable speed fan
Communications	- RS485 , baud rate 38400 , camera ID =1 , PELCO-D protocol

### Camera Processors:

- one 32 bit ARM based DSP with 8MB RAM
- two (one in camera and another in remote) 8 bit auxiliary processors

### Camera DSP Processing Functions:

Exposure - linear (normal), wide dynamic range (100dB dynamic range) , BLC (back light compensation) , HLI (highlight inversion) = synthetic coronagraph with user adjustable inversion level

- Gain control - Manual gain control camera front end for unmatched performance by any AGC type camera .
- Total gain range - 46dB
- BLACK LEVEL CONTROL - black level can be user adjusted from 0 to 1/4 of maximum white level
- Color balance modes - ATW , AWB , Manual , Push
- Color modes - Color, B&W user selectable
- Image FREEZE - remote , computer or camera OSD keys control
- Image mirror - left/right/up/down
- Digital zoom - user selectable ON/OFF
- Digital zoom range - from x1.0 , x1.1 , x1.2 to x10.0 in fractional increments
- Image sharpness adjustment - continuous in 0 to 100 range
- GAMMA - user selectable 0.3 , 0.45 , 0.6 , 1.0
- 3D\_DNR - IN CAMERA NOISE REDUCTION BY IN CAMERA FRAME STACKING up to 5 frames for total integration time OF 85sec/100sec (NTSC/PAL)**
- CRT and LCD monitor settings
- Automatic Pixel Correction - DPC (defective pixel correction) - user selectable ON/AUTO
- FLAT FIELD CORRECTION - user adjustable from 0 (no correction applied) to 100 (max correction applied). This compensates for vignetting in the telescope optical path , WITHOUT needing to take flats or use software!
- REMOTE CONTROL HANDBOX :
- manual gain adjustment (red illuminated rotary control with detents ) ,
  - manual gain digital display ,
  - user selectable display brightness
  - menu keys
  - IMAGE FREEZE button
  - RS485 interface for computer connection included in remote

## 21. UPGRADING

Astro-Video Systems Advanced Camera MK II , MK III and APU-1 firmware upgrades are free for the lifetime of the product.

Your MK II or III camera hardware can also be upgraded to the **Peltier Cooled Unlimited Integration Advanced Camera** APU-1 model .

The Advanced MK II/III Camera Complete System is also eligible for the Astro-Video Systems trade-in program (see website for details).



## APPENDIX 1 - USING IN-CAMERA STACKING

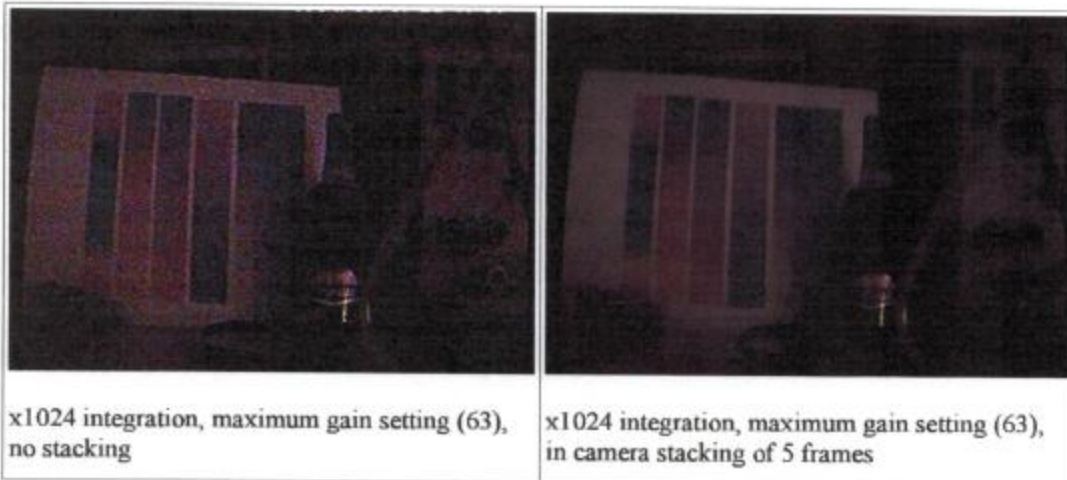
The MK II camera can be used for live viewing up to an integration time of 17 sec (NTSC) or 20 sec (PAL) in single frame no stacking mode.

This non stacking mode is the fastest display method but like any compromise, it trades speed and simplicity for performance.

The MK II camera can integrate up to 85 sec (NTSC) or 100sec (PAL) using the in camera stacking feature as described at page of the manual.

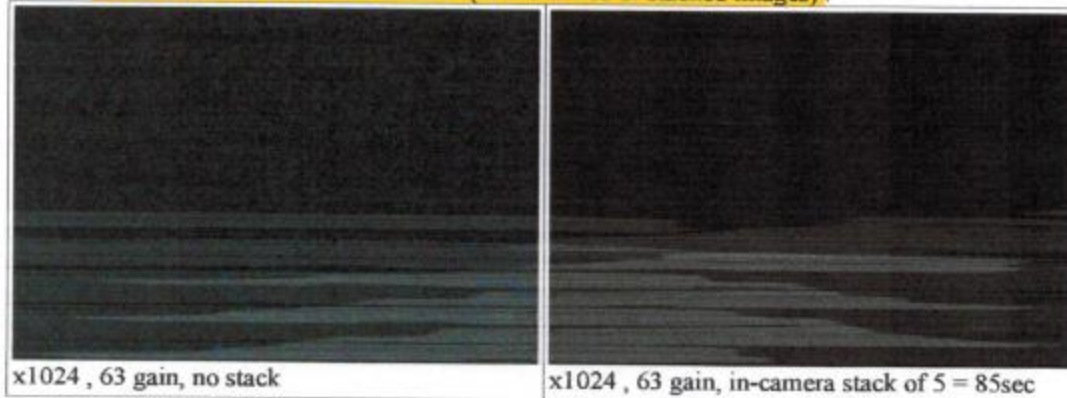
The 2 images below show a dark room test image taken at maximum gain (63 on the hand remote display) , under the same exact conditions and settings, except for the fact that the left image was a single frame and the right image used in camera stacking of 5 frames (with everything else being the same ).

The image quality difference is huge and shows that any time a good quality image is needed, using in camera stacking can match or exceed image quality obtained by Peltier cooled , much more expensive cameras from competing vendors .



The images below show the difference between 2 dark frames, both taken at maximum gain and maximum integration . The left image was taken with no stacking while the image on the right uses the in camera stacking . The dark frame that uses stacking is virtually noise free and amp glow free , at a total integration of 85sec (NTSC) or 100sec (PAL) and using maximum manual gain ( 63 on the hand remote display) .

NOTE: AMP GLOW DOES NOT EXIST (in unstacked or stacked images) .



A tutorial of how to use the in-camera stacking follows. Please read it carefully, the in camera stacking is a very powerful and flexible tool. It can lead to great results but it can also be misused if directions are not followed.

- in camera stacking is named 3D-DNR in the camera menu .  
It is found in the ENHANCE submenu.

- AGC (in Exposure Menu) should ONLY be switched to the LOW setting when you want to use in camera stacking .

- AGC should ALWAYS be set to OFF when in camera stacking is not used. This must be very clear.  
**AGC SHOULD ALWAYS BE SET TO OFF  
THE ONLY TIME AGC IS NOT SET TO OFF BUT TO LOW IS DURING IN CAMERA  
STACKING**

This statement is so important, it should be printed on each page of this user manual, so here it is again:

AGC should ALWAYS be set to OFF every single time in camera stacking is not used. If AGC is set to LOW/MED/HIGH without using in camera stacking, unpredictable , unreliable low quality images are generated.

- 3D-DNR in the Enhance Menu is recommended to always be left set to a value of 5 for minimum noise .

The 3D-DNR in camera stacking is not activated until AGC is set to LOW .

As long as AGC is OFF, the in-camera stacking is OFF, regardless of the 3D-DNR setting .

A lot of unnecessary menu navigation can be avoided by leaving the 3D-DNR preset to 5 and switching stacking on/off by turning AGC OFF / LOW.

- WHEN IS STACKING NEEDED:

You can safely use the remote manual gain values between 0 to 35 without visible noise even in hot temperatures .

In the 35-45 remote manual gain range especially at the upper end of the range there will be some noise when no in camera stacking is used and in hot temperatures.

Manual gain of 63 can be used absolutely noise free ONLY when in camera frame stacking is used (values 1 to 5, 5 is recommended). Stacking 5 frames totally removes all noise .

Stacking is more demanding of mount tracking or guiding because it allows up to 85sec/100sec integration, whereas single frames require only up to 20sec of good tracking .

When in camera frame stacking is used, there is a certain sequence that must be followed to adjust the hand remote manual gain (or PC controlled) , AGC and IMAGE BRIGHTNESS in the exposure menu.

When this sequence is followed, the camera runs at manual gain of 63 , up to maximum integration and in color , with zero or very low noise .

#### QUICK TEST:

- to quickly test the in camera frame stacking, cap the camera with a real metal cap (plastic allows IR to pass) , make sure there are no light leaks and set the 3D-DNR to 5 .

Set brightness in the exposure menu to a very low value, 3 to 5 .

Set manual gain to 63 val.

Set long integration to x1024 (it works for other integration times but x1024 is the best example because it would have the most noise).

Set AGC to Low .

Don't forget to save and exit (not just exit, or just return).

Wait for 3 integration cycles for the camera to purge its frame buffer of the previous frame, then the first new frame performed at x1024 , which WILL show amp glow, then the 3rd cycle the amp glow is gone from there on for subsequent cycles.

The dark current and noise level will be visibly lower after the amp glow frame elapses , but still there will be a visible level of noise and dark current .

Gradually change brightness from the exposure menu from the initial low values to mid values, in 10-15 unit increments.

**THIS STEP IS A MUST. YOU HAVE TO START FROM LOW VALUES** and change gradually.

It will get to a value where suddenly all the dark current, noise , most hot pixels will vanish .

It's a relatively slow process because the brightness setting change must be gradual (wait for the next integration cycle to change the value, only one value change per integration cycle) .

It's important to not overshoot the correct value because if the BRIGHTNESS value in EXP menu is set too high, the camera AGC tries to bring the overall screen brightness to this set too high value and as a result the brighter peaks including the colors get clipped and desaturated quickly.

#### ALTERNATE PROCEDURE:

After you experimented with the in camera stacking as above and became familiar with its operation, a much faster procedure can be used .

It's the same as above, except it assumes you already are good at estimating the BRIGHTNESS level that is required in the Exposure menu.

Instead of gradually increasing the Brightness, you will set it directly to your best estimate value. Then turn AGC to LOW , save and exit.

If the in camera stacking seems instantaneous instead of ramping up gradually , brightness (in the exposure menu) estimate was too high and must be reduced.



If stacking still doesn't kick in, reduce the manual gain from the remote gain knob or from the computer AstroVideo Control Panel gain slider .

You can go all the way to a gain of 0, then gradually increase it .

The increase from 0 back to 63 should be gradual and take 5-10 seconds.

You will see that there's a point where the camera triggers the stacking and noise gradually vanish.

When you are able to do this with dark frames as described above, you will see the dark noise and current drop to a virtually invisible level.

The same procedure applies to real viewing or imaging, not just dark frames.

The difference is that depending on target brightness, sky fog and how much of the field of view is taken by the target , the brightness value that must be set in the EXP menu is different for each different target .

When you get an image you like on screen, it's simple to just freeze it using the remote FREEZE on/off key.

After the image is frozen, there is plenty of time to capture it and readjust the frame grabber settings until they're the way you want them.

Remember, the image is frozen in the camera and the video capture happens at the camera output .

This allows you to capture on your PC or other video capture device multiple images with different settings from the same single in camera frozen frame.

#### NOTE:

If despite your attempts the camera goes too quickly thru the stacking process because brightness (in EXP menu) was set too high, the image quickly becomes too bright and colors get washed out relatively fast.

In order to restart the stacking with better settings, which will display steady colors without becoming gradually brighter and washed out, you have to enter the EXPOSURE menu , go to BRIGHTNESS and reduce the value by 5-10 units.

Then, without exiting the Exposure menu, go to AGC situated just above.

Switch it from LO to OFF .

In 1- 2 seconds , the camera will switch stacking off and you can immediately switch AGC back from OFF to LOW .

It is important to do it in this order , first readjust brightness and then do the AGC off then on again .

Don't forget to save and exit from the bottom line of the Exposure menu (named exit and you scroll right to get save&exit).

Any changes to this procedure, such as running stacking with manual gain set to lower or med values, or using a different procedure, will give inconsistent results at best.

For best results, manual gain should always be over 50 (recommended over 60) on the hand remote display . This will generate the lowest noise final stacked image .

Sometimes, especially if the scope doesn't have good tracking, the in camera stacking will appear to disable itself at gains over 60 on the remote display .

However, what really happens is the camera continues to stack but due to the fact that the image is shifted around and the frames to be stacked do not register properly, the noise doesn't get canceled.

When this happens, if you can't improve the mount tracking or guiding, just drop the manual gain to 50 and then gradually increase it back. **DO NOT LEAVE GAIN TO THE LOWER VALUE.**

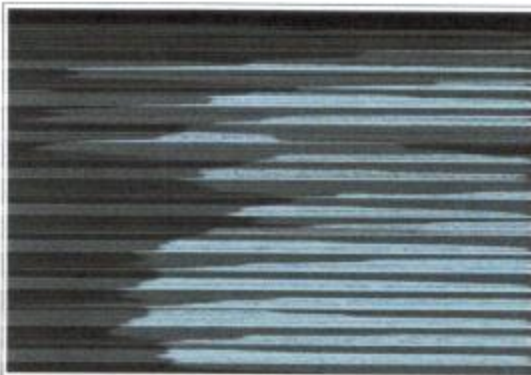
Increasing manual gain slowly, you will see that it works all the way to 63 or close to it. When you get the desired image quality, use the remote FREEZE key to store it.

Below is an image taken in the same dark room, under the same exact illumination conditions, using the same settings as the in camera stacked test images.

The manual gain was set to "00" on the hand remote display (or computer control software).

There is virtually nothing in the image, because 00 gain is about 200 times lower gain than the maximum setting of 63.

In order to get the same image brightness as in the maximum gain stacked image, at 00 gain the camera would need 200 times longer integration or  $85 \text{ sec} \times 200 = 17,000 \text{ sec}$ , almost 5 hours!



- this image taken at a gain of 00 and 17sec integration would need 5 hours integration to achieve the same brightness as the image on the right (taken in 85 sec using in camera stacking and maximum gain)



- this image was taken at total integration of 85sec using in camera stacking of 5 frames (17sec each). The image on the left, taken under the same light conditions but with a gain of 00 and no stacking, is totally black due to insufficient gain/exposure.



If the in camera stacking procedure is not followed correctly, the camera might still stack images as shown on the left, but quickly desaturate colors. The result will be noise free but little color left. This typically indicates an EXPOSURE menu BRIGHTNESS value that is too high. Always follow the described procedure to stack images.

For illustration, all 3 above images are using the same illumination conditions as the images on pg. 22, with different manual gain and in camera stacking settings.



## APPENDIX 2 - WHITE SCREEN - CCD PROTECTION

The MK II camera has a protection function that can get activated automatically under several setting combinations or even at power up if the camera processor detects an unusual power surge or a camera out of sync condition.

When this protection is triggered, the camera will power down some circuits and the CCD and the result is it displays a white screen .

The camera can exit this mode most of the time by itself , assuming the condition that triggered the protection is no longer present , although sometimes it can take it a relatively long time of several integration cycles and some other times it may remain in this protection mode even if power is cycled repeatedly.

The following is a simple procedure to exit this protection mode manually and it only takes a few seconds and a few menu key presses:

- go to EXPOSURE/LENS/ELECTRIC submenu
- scroll (using the left/right arrow keys) from the current slow shutter value it was at , all the way to auto and then pass it to maybe 1/250 .

- then scroll back to slow shutter values . Keep scrolling to increasing values, x2, x4 etc .

- You'll see that when you reach past x8 , the camera DSP resets from protection mode and frames become normal again.

- as always, go down to the bottom of the Exposure menu , to EXIT (just go down to EXIT but DON'T exit) , then scroll right until SAVE&EXIT is visible and select it .

Without save&exit, the camera does NOT retain the changes you made and will revert back to the previous settings after about 20 seconds.

- because the camera DSP can enter this protection mode under certain menu changes, it's advisable to change integration always last.

The only O.S.D. adjustment that should be made after setting a new integration time (in the same menu operation) is the AGC between OFF and LOW if you need to switch on/off in camera frame stacking (remember AGC should always be OFF if no stacking is used) .

NOTE: there is no danger to the camera to exit the white screen protection mode manually at any time. If the camera encounters another trigger condition , it will simply re-enter protection mode.

The protection trigger circuitry has a built in safety margin so it will trigger on any potential hazard because it is better to err on the safe side .

Changing or saving some camera setting combinations might "look" to the camera processor very similar to some hazard conditions and a false trigger might occur sometimes, especially when integration is changed .

It is perfectly safe to manually exit this protection mode as described above, the camera will always be able to protect itself from any real hazard , no matter how many times a user tries to exit the protection mode . Manually exiting the protection mode as described above does not disable the protection function . The protection function is ALWAYS active and can not be disabled .

### APPENDIX 3 - USING THE BLACK LEVEL ADJUSTMENT - MK III ONLY

The remote handbox black level adjustment key and the PC control software BRIGHTNESS slider (do not confuse this with the camera O.S.D. EXPOSURE menu, where there is a different setting named BRIGHTNESS ) is an essential adjustment for image quality, contrast, noise levels and visible detail level.

The remote black level is adjusting the reference point at which the CCD output signal is considered black by the camera DSP (digital signal processor) .

This is NOT done via image processing after analog to digital conversion.

This black level adjustment is performed right at the signal source, at the CCD sensor output , BEFORE A/D conversion .

If this level is set too dark, details will be lost in the shadows , without any possibility to regain them via further processing down the signal chain .

If this level is set too bright, the image will lack contrast and dynamic range. While contrast might be regained to some extent by further processing later down the signal chain, this can only be done at the expense of dynamic range and increases noise levels .

Because this adjustment is so close to the signal source ,setting the camera black level is one of the most important elements in obtaining a good image .

Remember, to have a good image you have to maximize the signal quality that is ENTERING your video camera system .

It's simply the old GIGO principle (garbage in, garbage out).

The manual gain and black level are setting this signal quality, together with integration time .

The MK II camera has this black level set automatically by its camera signal processor. Due to the variety of astronomical targets and their very different parameters, automated adjustments work only with a limited amount of success .

No camera processor or computer software could read minds and guess what parts of the field of view are most important for the observer. It could be the brightest elements, requiring a high dynamic range setting. It could also be the opposite, details that were hidden in the shadows . The MK III upgrade brings this under direct user control .

Usually , manual gain control and black level adjustment are part of video studio high grade professional gear and are found in dedicated separate proc-amps (at costs that exceed many times the MK III camera price). The addition of these controls allows the MK III camera to perform this function , avoiding the extra bulk, cost and complexity of a separate proc-amp , while allowing total user control of image parameters .

Here are 3 images taken under the same exact conditions and with the same settings, except for different black levels .



- image taken with darkest black level  
- setting of "0" in the PC control software Brightness level .



- image taken with black level at 1/2 setting.  
- setting of "128" in the PC control software Brightness level .  
Please note the details that are visible in the left image but were totally lost in the black areas of the image above with the "0" setting .



- image taken with black level at max .  
- setting of "255" in the PC control software Brightness level.

Please note even more details emerged from the dark areas, while the grey tone gradient card is still unaffected .

The black became lighter but the light grey did not become whiter .



The **CAMERA** internal circuitry allows a continuous black level adjustment with a range of 0 to 255 in one unit increments .

In order to not add too much complexity to the hand remote , the **remote** black level key only steps thru 8 black level values , equally spaced from darkest to brightest .

The **PC software** generates the whole range from 0 to 255 with a step of one unit .

When the camera is connected to a PC and controlled via software , black level can be adjusted both from the remote and from the PC software .

The remote will always step only thru the 8 steps while the PC always allows continuous adjustment.

Black level control from the remote handbox and PC can be mixed , for example the user can slide the PC software BRIGHTNESS slider to set any desired black level value , after which press the hand remote black level key to step to the next remote generated value.

#### IMPORTANT NOTES:

The **white level** is adjusted via the manual gain control .Both the remote gain knob and the software GAIN slider perform this function and can be used simultaneously , adjusting the same camera circuitry.

The new MK III black level adjustment on the **remote** powers up at a default medium value, halfway between the darkest and brightest background values.

The first black level remote key press adjusts the black level to the darkest background.

**Adjusting the black level does NOT affect the white level .**

Each subsequent remote black level key press steps to successively brighter black levels , for a number of 8 black level steps, after which the cycle repeats.-  
BLACK LEVEL ADJUST - steps black level thru 8 successively brighter steps , from darkest to brightest .

ATTENTION - this modifies only the black level , NOT overall image .

## APPENDIX 4 - USING THE ARTIFICIAL CORONAGRAPH

The MK II/III camera has a special mode for viewing very bright targets in the same field of view with very dim ones .

This function creates digitally a “mask” that is applied by the camera processor in front of the bright target , allowing the surrounding lower brightness areas to be viewed without the image being overwhelmed by the bright target.

This function is called artificial coronagraph (although there are no natural ones ) because the mask doesn't physically exist and is generated digitally thru computations by the camera processor .



In order to activate the artificial coronagraph mode, open the Exposure menu and select (click the enter key) the topmost item, also called Exposure.



Scroll its value using the left/right arrow keys from normal to HLI (highlight inversion) .

HLI blackens all image areas that are brighter than the user set threshold HLI level.

Do not forget to return, then SAVE&EXIT .

## APPENDIX 5 - FOCAL RATIO , FIELD OF of SCT SCOPES

All modern Schmidt-Cassegrain and derivative scopes are designed to cover a relatively large size focal plane . Most of these scopes were designed not too long ago when film was still used and are able to cover at least an APS-C size sensor or a full frame 35mm (image circle of 43mm diameter and 1451 sq mm area).

A lot of owners use these scopes with astronomy video cameras , which have very small sensors compared with the telescope illuminated image circle.

Here is a scale image showing the most common sensor sizes and comparative fields of view :



Table - telescope eq. aperture with same light gathering as 10" SCT without reducer

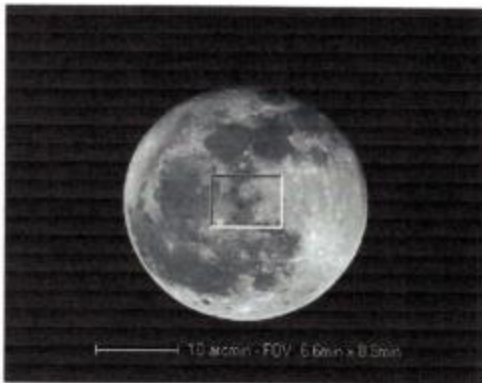
SIZE	DIAG (mm)	AREA (sq mm)	% of image circle area	Equivalent aperture D	Pixel Scale (arcsec/pix)	Field of View
full fr. 35mm	43mm	860	59.00%	7.7 inch	0.48	1 deg
APS-C	26mm	370	25.50%	5 inch	0.4	36 arcmin
4/3 four thirds	21.6mm	225	15.50%	4 inch	0.35	26 arcmin
2/3 inch	11mm	58	3.99%	2 inch	0.53	15 arcmin
1/2 inch	8mm	30	2.06%	1.4 inch	0.75	10.5 arcmin
1/3 inch	6mm	17.3	1.20%	1.1 inch	0.51	8.5 arcmin
1/4 inch	4mm	7.7	0.53%	0.7 inch	0.5	6 arcmin

Below are simulated images to compare same scope field of view with different sensor sizes at the scope native F/10 :



35mm full frame field of view at F/10  
- field of view 1 degree  
- pixel scale 0.4 arcsec/pixel

NOTE: the field of view is the white rectangle



1/2 inch sensor field of view at F/10  
- field of view 10.5 arcmin  
- pixel scale 0.75 arcsec/pixel

NOTE: the field of view is the small white rectangle



1/3 inch sensor field of view at F/10  
- field of view is 8.5 arcmin  
- pixel scale is 0.51 arcsec/pixel

NOTE: the field of view is the small white rectangle

It is very clear that using the scope (in the above example a Meade 10" F10 SCT ) with ANY video camera , whether it has a 1/2" CCD such as the Mintron, G-star, Orion , Mallincam, or a 1/3" CCD such as the Astro-Video Systems MK II/III , results in an extremely small field of view, which is insufficient for most targets except for planets and some small planetary nebulas .



As seen in the above images, the field of view difference between 1/2" and 1/3" sensors is negligible . The 1/3" sensor has a f.o.v. of 8.5 arcmin while the 1/2" sensor has a f.o.v. of 10.5 arcmin . The difference is 2 arcmin in a telescope with a f.o.v. of 1 degree!

It is clear that all astronomy video cameras need to be matched to the scope by using appropriate focal reducers .

The maximum practical reduction that can be obtained is a function of sensor size to scope image circle diameter ratio .

Cameras that use 1/2 inch sensors ( 8mm diagonal) use reducers in the F/3 - F3.3 range , anything faster causes vignetting and increased optical aberrations .

Cameras using the smaller 1/3 inch sensors (6mm diagonal) can use stronger reduction , down to F/1.8 -F/2 .

The only commercially available F/2 option involves removing the secondary and replacing it with a relatively large, expensive, heavy, fragile assembly and attaching the camera and its cables to the FRONT of the scope corrector plate .

The Astro-Video Systems F/1.8 reducer is used by attaching to the telescope rear port and is the only F/1.8 reducer commercially available today for video astronomy.

Below are 2 simulated images showing f.o.v. of 1/2" and 1/3" CCD cameras using the same 10" telescope and the highest reduction available for each sensor size.



1/3 inch sensor field of view at F/1.8  
- field of view is 45 arcmin  
- pixel scale 2.8 arcsec/pixel



1/2 inch sensor field of view at F/3.3  
- field of view is 32 arcmin  
- pixel scale 2.3 arcsec/pixel



The following actual image (not simulated) was captured using an Astro-Video Systems MK II/III camera with a Meade 10" SCT and an Astro-Video Systems F/1.8 reducer :



When a MK II/III camera is matched to an 8-14" SCT telescope by using the F/1.8 reducer , image scale is around 2.8 arcsec/pixel , which matches the atmospheric turbulence limit of most viewing sites.

This results in images that are reasonably sampled , having enough resolution without oversampling atmospheric turbulence . Such an image scale ensures the fastest image integration times .

The field of view using the F/1.8 reducer is around 45 arcminutes, very close to the maximum field of view of the telescope , so nothing is wasted there as well .

#### NOTES:

##### 1 - EQUIVALENT APERTURE:

The table on page 32 shows an equivalent telescope aperture for each sensor size. It indicates what effective telescope aperture the sensor is really using .

Due to the fact that the telescope has an image circle that is much larger than the camera sensor, most of the telescope light simply passes by the sensor and is lost, instead of falling on the pixels .

For example, if a 1/2" CCD camera is used at F/10 with a 10" SCT/ACF/HD/Edge telescope, the fraction of light that is captured by the telescope aperture AND falls on the CCD is equivalent to a 1.4" aperture . That's right, your beautiful 10" scope is reduced to the light collecting power of a 35mm finder . Unless a very strong reducer is used, most of the telescope light cone will be wasted and not fall on the camera sensor.

##### 2 - IMAGE SCALE:

All cameras in the page 32 table are having a remarkably similar image scale, ranging from 0.4 arcsec/pixel to 0.7arcsec/pixel. Such an image scale is adequate for detailed imaging of planets for example, provided lucky imaging software stacking of tens to thousands of frames is used , otherwise it is just a total mismatch . Atmospheric turbulence limits seeing for the vast majority of amateur sites to values in the several arcseconds . This also points out to the need of using a strong focal reducer to bring the image scale from 0.5arcsec/pixel to a more adequate value such as 2.5arcsec/pixel for DSO viewing under normal seeing conditions.

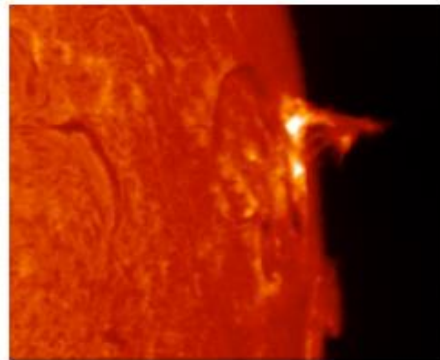
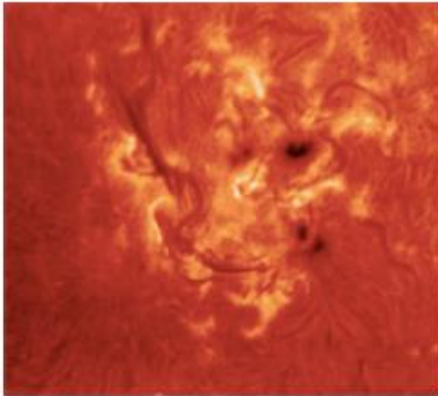
# **Appendix B**

**Manual for**

**DayStar Hydrogen Alpha  
Solar Filter System**

Company Seven  
Astro-Optics Division

## The DayStar™ Filter An Operating Manual



**Hydrogen-Alpha Series: ATM and UNIVERSITY (Oven Models)**

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## The DayStar™ Hydrogen-Alpha Filter An Operating Manual by Company Seven

MODEL: ATM    SERIAL No. U-1804    BANDPASS: 0.6 Å

ON BAND DIAL SETTING 5.0 (High Contrast), **DO NOT EXCEED 9.0 SETTING**

NOMINAL SETTINGS FOR FILTERS WITH OPTIONAL  $\pm 1.0\text{Å}$  OFF-BAND TUNING:

-1.0 Å SHIFT INTO BLUE: DIAL SETTING = 1.0 For Extensive Doppler Work

+1.0 Å SHIFT INTO RED: DIAL SETTING = 8.0 For Extensive Doppler Work

You have purchased a filter that can introduce you to another world. Please take a few minutes to read this manual keeping in mind that this will help you to progress much more rapidly than you might otherwise.  
Martin Cohen, Company Seven

### I. An Introduction to Solar Observing and Hydrogen Alpha Light:

DayStar filters are uniquely designed to transmit a narrow section of the solar spectrum while reflecting or absorbing undesirable parasitic light. To accomplish this white light (produced by a combination of colors) must be broken down into its constituent form to produce a rainbow of colors. Each color is measured in Angstrom units, each representing  $1 \times 10^{-10}$  meters. The symbol for Angstrom is Å. The human eye can discern colors within the rainbow from about 3800Å in the violet through to about 7000Å in the crimson. Within sun light the continuous spectrum visible in white light is interrupted by a series of black bands called absorption lines; these lines are primarily created by cool absorbing gases located in the Sun's upper photosphere or chromosphere. In order to observe phenomena interacting with hydrogen or calcium, very precise optical filtration is required. Company Seven can support studies of most portions of the solar spectrum.



Left: The Sun as seen through a "White Light" Filter.

The photosphere is the visible surface of the Sun that amateur astronomers are most familiar with. The visible surface of the Sun is not a solid surface, but it is actually a layer of the gas ball that is about 100 km thick; this is relatively thin compared to the 700,000 km radius of the Sun. The photosphere is readily observed with relatively inexpensive solar filters several of which we offer. When observing the center of the disk of the Sun we look straight in and see some hotter and brighter regions. When one observes the limb of the solar disk that light has taken a slanting path through this layer and we only see through the upper, cooler and dimmer regions. This explains the limb darkening that appears as a darkening of the solar disk near the limb. A number of features can be observed in the photosphere with a simple telescope equipped with a suitable "White Light" filter with a metal coated glass or polymer element, designed to reduce the intensity of sunlight to comfortable levels, and to eliminate or attenuate harmful portions of the spectrum.



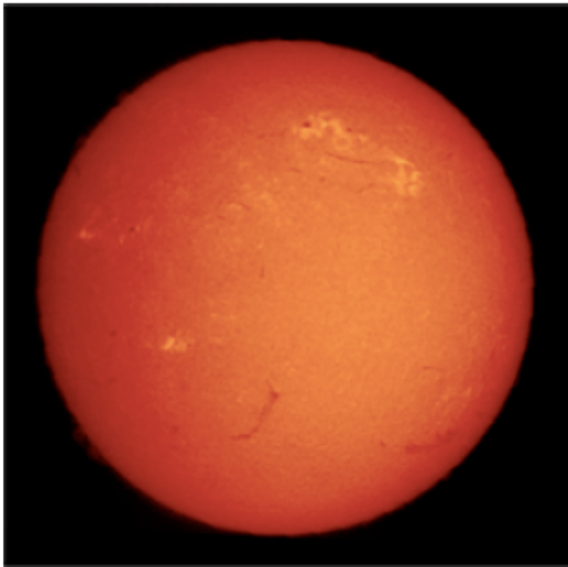
Depending on the nature of the coating or metal used to make the filter the Sun may appear white, blue, yellow (as shown above), or orange red. The features visible in a white light filter may include 1. dark sunspots, 2. the bright faculae, and 3. granules. One can also measure the flow of material in the photosphere using the Doppler effect. These measurements reveal additional features such as supergranules as well as large-scale flows and a pattern of waves and oscillations.

The chromosphere appears as "peach fuzz" surrounding the Sun. This is an irregular layer above the Sun's photosphere where the temperature rises rapidly from 6000° C to about 20,000° C. At these higher temperatures the hydrogen emits light that gives off a deep red color (H-alpha emission). The chromosphere derives its name (color-sphere) from these phenomena. This colorful emission can also be seen in prominences that erupt and then project to beyond the limb of the sun into the black background of space. Prominences may be safely observed by the naked eye during total solar eclipses.

However, when the Sun is studied through a spectrograph or a filter that is engineered to isolate the H-alpha emission, then many more features are revealed including: the chromospheric network of magnetic field elements, bright plage around sunspots, dark filaments across the disk, and prominences beyond the limb.

The most commonly used portion of the spectrum for serious studies of the Sun is in the red portion of the solar spectrum, specifically at the line of Hydrogen Alpha located at 6562.81Å. At its half intensity point, this line is only 1.20Å wide. Consider that a 0.5Å bandpass filter is passing only about 1/8000 of the frequency band of visible light! Providing optical filtration in this order of dimension is most demanding, and DayStar is among the few manufacturers who has historically proved to be able to do this consistently well, and with good durability and longevity of the filter system.

### DayStar Hydrogen Alpha Filters



DayStar monochromator filtration technology progressively isolates a prominent absorption line from the rest of the spectrum, and then transmits it through to an eyepiece, camera, or sensor. Delivering high purity filtration for solar observing involves relatively new and innovative thin film coating technologies; to fill this need DayStar has developed a computerized controlled laser assist coating process. This and other technology improvements over the recent decades has made it possible to produce higher quality components to meet the increasing needs of our customers.

Sunlight passes through a series of critical filter elements including: an anti-reflection coated optically flat window, narrow band blocking filter, an etalon window, a Fabry-Perot solid space crystal (carefully produced in house by DayStar), a second etalon window, broad band trimming filter, and another AR coated optically flat window.

Left: Sun as shown in a DayStar Hydrogen Alpha filter.

## II. The DayStar Filter System Components:

The DayStar Calcium K-Line, T-SCANNER™, ATM and UNIVERSITY filter systems each have two primary components: the Filter Body, and an Energy Rejection Prefilter (ERF).

All optical interference filters are sensitive to changes in temperature. The Bandpass will shift towards the longer wavelengths with an increase in temperature, or towards the shorter wavelengths with a decrease in temperature. The standard DayStar filter shifts at a rate of 1.0 Å per 16.8 degrees F change. The narrower the filter bandwidth is, then the more precisely the temperature must be regulated.

Therefore, each DayStar Calcium K-Line, ATM and UNIVERSITY filter is installed in a cylindrical temperature regulated oven allowing  $\pm 0.05 \text{ \AA}$  on band control. Considering the absorption band is only  $1.2 \text{ \AA}$  wide at its half intensity point, such control is absolutely required. The Calcium K-Line, ATM and University filter models employ an integral heater and controller to precisely regulate the temperature of the filter elements, therefore your instrument will have a power cord and control dial attached to the filter housing.

The DayStar Filter Body:

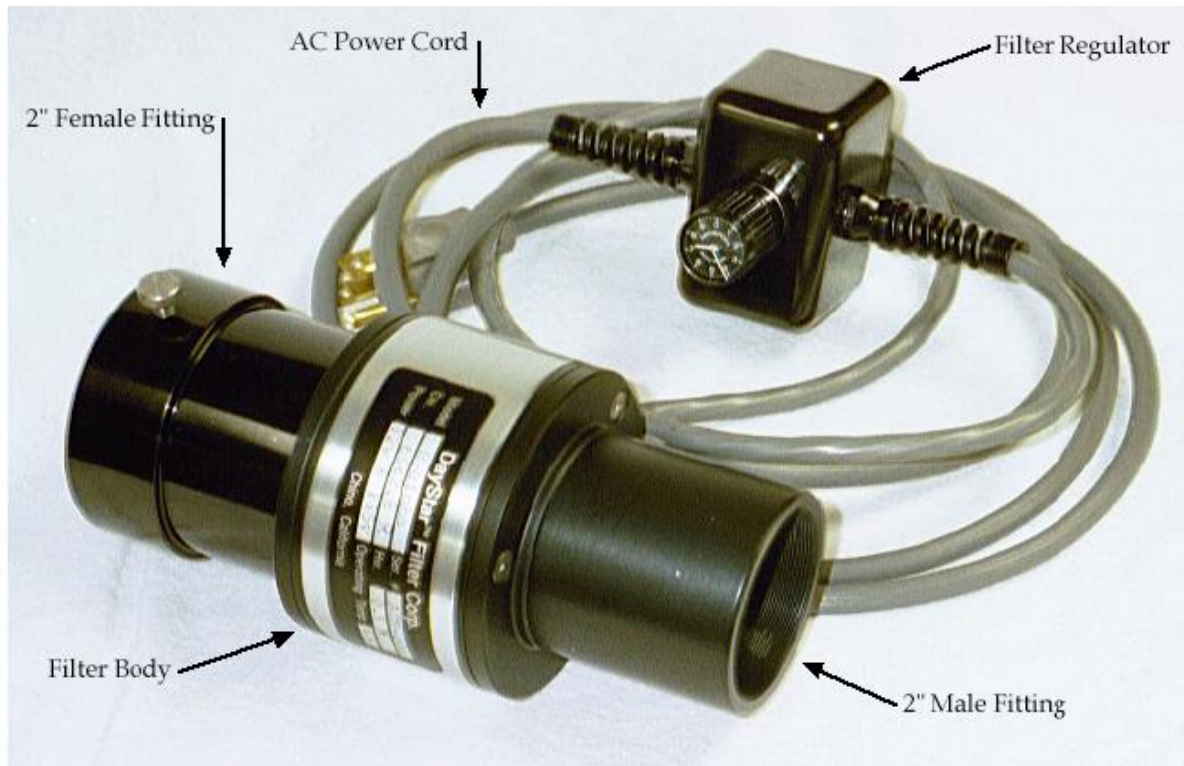


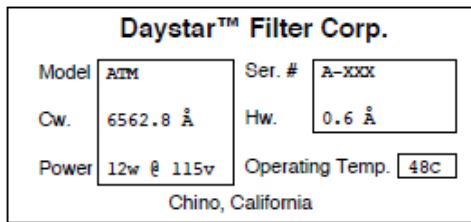
Illustration 3: DayStar Filter Body with Flanges installed at each end.  
 Note the optional two inch Male and Female fittings which are threaded into the Filter Body Flanges.

The standard Calcium K-Line, ATM and University Filter Body has a clear 32mm aperture, although other apertures are available by special order. This filter body accepts bolt on parallel or wedge shaped accessory mounting flanges. These flanges will be selected based on the telescope on which the DayStar filter is to be employed. The filter must be equipped with the appropriate optional mounting hardware and flanges to attach the system onto a telescope. And the filter must also be provided with those fittings necessary to accept the visual or imaging accessories. The DayStar filter body as typically furnished by Company Seven is provided with Flanges to install the filter onto and to accept either 1.25 or 2 inch diameter "slip on" fittings, or with Questar or Celestron fittings, or what custom fittings are specified. Company Seven offers a good selection of hardware, with the expertise to recommend what may be appropriate for your needs.

#### DAYSTAR FILTER BODY SPECIFICATIONS

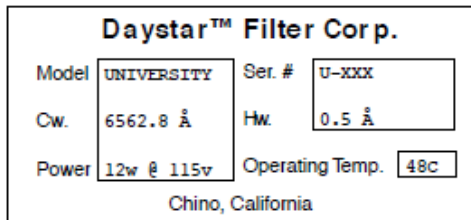
Diameter: 3.00" (76mm)  
 Body Length: 2.00" (52mm)  
 Weight: Approximately 1.0 pound (0.453 kg)  
 Power: 12-30 W at 115V AC, 50-60Hz 60Hz (a converter from 220 volt to 115 may be required)  
 Power Cord: Three wire grounded, 6.6 feet (2.0 meters) long.





Cw. = Central wavelength in Angstroms  
 Power = Wattage and Voltage requirements  
 Ser. = Serial Number  
 Hw. = Width of Bandpass in Angstroms  
 Operating Temp. = Nominal Temperature required to achieve the Hw. This can be adjusted at the dial on the power cord.

Illustration 4: Label on a DayStar Filter (ATM Model Label shown)



Cw. = Central wavelength in Angstroms  
 Power = Wattage and Voltage requirements  
 Ser. = Serial Number  
 Hw. = Width of Bandpass in Angstroms  
 Operating Temp. = Nominal Temperature required to achieve the Hw. This can be adjusted at the dial on the power cord.

Illustration 5: Label on a DayStar Filter (University Model Label shown)

The DayStar filter power cords are provided with a precisely calibrated, ten turn knob pot for adjusting the oven temperature thereby optimizing contrast. This is also used for setting the optional  $\pm 1.0 \text{ \AA}$  off band tuning for research applications including Doppler work. The proper dial setting for "On Band" is specified at the top of Page 3 of this manual. For models suitably equipped the proper dial setting for this filter "Off Band Shift into the Blue" is also specified at the top of Page 3 of this manual, the proper setting for "Off Band Shift into the Red" is specified too. **These settings are specific to each instrument and may vary from one filter to another.** The suggested Peak Setting (usually 9.0) should never be exceeded or damage to the filter may result!

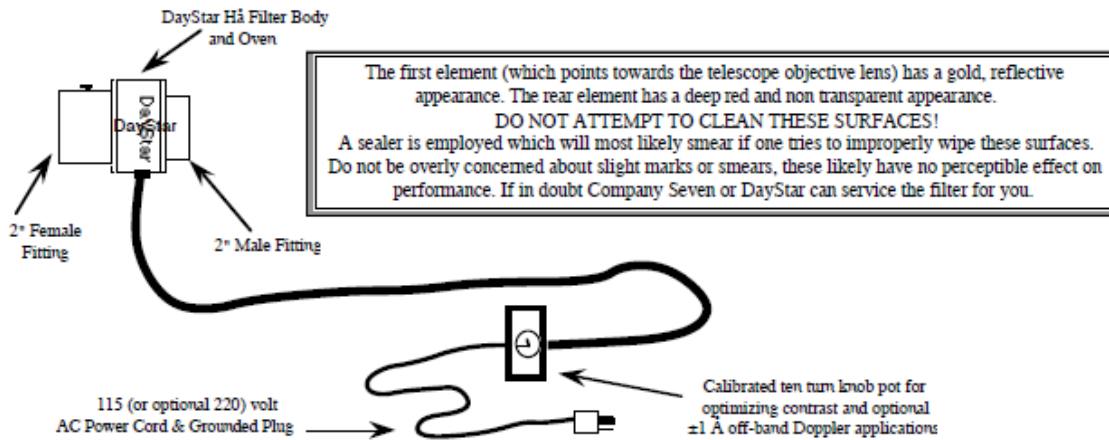


Illustration 6: Arrangement of DayStar ATM, UNIVERSITY model filter.

The Energy Rejection Filter (ERF):

The Energy Rejection Filter (ERF) sometimes called a "pre filter" is an essential component of a DayStar Hydrogen-Alpha system. Each is a custom engineered glass filter of a specific deep red color, mounted into a cell that is attached over the front of the telescope to cut down about 80% of the off band solar energy. More importantly, the ERF is a component designed to assist in the elimination of ultraviolet solar energy.

The filter is so precisely ground plane parallel, and smoothly polished so that the transmitted wave front as provided by Company Seven will not exceed one quarter wave Peak to Valley at 6563 Å (Angstroms). **No other Energy Rejection Filter should be substituted.**

The DayStar Hydrogen-Alpha filter is engineered to work best with a system providing an f30 beam. This is nearly parallel light. The f30 ratio may be obtained from a telescope by either:

1. choosing to employ a telescope that by design is an f30 system, or
2. stopping down the aperture of a telescope. For example, a six inch f15 refractor stopped down to a three inch aperture becomes f30, reducing a telescope's effective aperture by half doubled the Focal Ratio. The ERF aperture may be calculated to shape the cone of light passing through the telescope into a f30 beam.
3. employing an ERF with optional optical elements to shape the beam into the f30 cone.

Earth's atmosphere only rarely permits seeing conditions as good as 1 arc second. So observers will rarely benefit from employing apertures much larger than 4 inches, or as much as 7 to 9 inches under the best of skies. Furthermore, the cost or availability of a large ERF may become limiting factors. The ERF may not by design need to cover the full aperture of the telescope. A partial aperture filter may be installed so that it is positioned in the center ("on axis") of unobstructed telescopes such as the refractor; this is to say that an eight inch aperture refractor may use an ERF only less than eight inches in aperture. Most observers will prefer to employ the largest practical aperture ERF in order to provide better resolution; this may show more detail than a smaller ERF depending on local "seeing" conditions. However, while Company Seven does often manufacture filters for operation of 13 cm to 15cm apertures (and occasionally larger), our experience shows stunning results may be obtained employing apertures as small as 80mm.

Note however, that telescopes with a central obstruction including the Cassegrain or Newtonian would require an "off axis" filter so that light from the filter is not obstructed by the central obstruction, or by its supports. And so for example, 14 inch Schmidt Cassegrain telescope may employ a five-inch filter off axis.

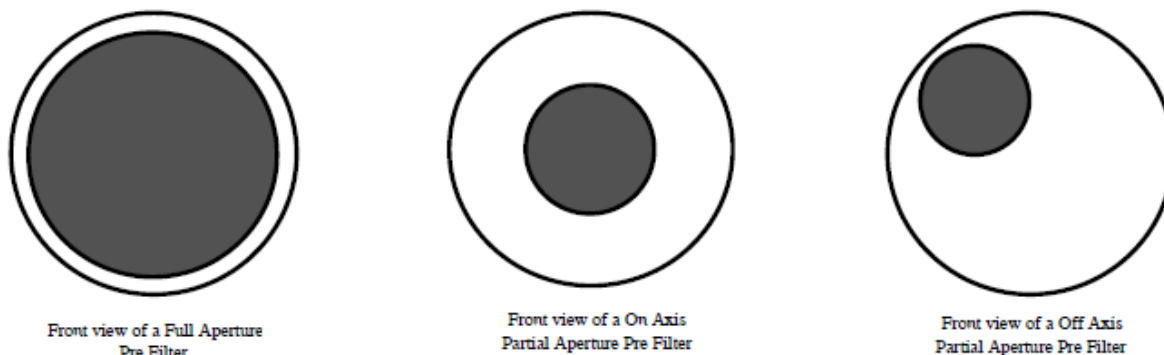


Illustration 7: Three possible arrangements of the Energy Rejection Filter.

For example a 6 inch (15cm) aperture 90 inch (2,286mm) focal length f15 refractor would require a 3" (76mm) diameter ERF. The 90 inch focal length divided by the three-inch aperture provides the nominal f30 ratio.

In another example (illustrated at right) an 8 inch (20cm) aperture 80" (2,032mm) focal length f10 Cassegrain telescope would require a 2.7 inch (68mm) diameter ERF. That ERF installed over the front cell would cut the effective aperture to 3 inches. The ERF element must be precisely positioned off-axis in such a manner that the ERF is not blocked by the Secondary obstruction, and so that the ERF does not extend to beyond the periphery of the telescope Primary Mirror.



Illustration 8: Celestron C-8 with DayStar Filter and Off Axis Prefilter attached.

In addition to the Filter Body and ERF other optional accessories including a matched Telecentric beam shaping lens, a Barlow (negative lens), or other device may be employed to form the beam of light exiting the telescope into the f30 cone. By increasing the effective focal length through the use of a diverging lens one may employ a larger aperture ERF. However diverging (Barlow) lenses alone are rarely the best solution since it is the *Angle of Divergence* of the light is the most critical characteristic of the f30 beam. This is why Company Seven offers several Telecentric lenses, some matched to a negative element.

For example: a 6 inch (15cm) aperture 90 inch (2,286mm) focal length f15 refractor telescope using a DayStar Hydrogen-Alpha filter could use a 3 inch (76mm) diameter ERF to attain an f30 beam. However, if we employ a 1.5X Barlow lens then the 6 inch f15 telescope becomes an f22.5, 135- inch effective focal length system. To get this telescope to f30 divide 135 by 30 and this will suggest the need for a 4.5-inch diameter ERF.

Keep in mind that a Barlow lens produces varying effects depending on the accessory used. A Barlow is a diverging lens placed before the focal plane. The farther behind the Barlow lens an accessory is positioned, the greater the image is enlarged. We sell a 2 inch 2X Barlow lens of first quality that actually averages 1.7X when an ocular is attached directly into the Barlow, but 2.3X when a 2-inch mirror diagonal is placed between the ocular and the Barlow lens.

<u>Astro-Physics</u>	<u>Avg. EFL</u>	<u>Prefilter w/2X Barlow</u>		<u>Celestron</u>	<u>Avg. EFL</u>	<u>Prefilter</u>	<u>w/2X Barlow</u>
4" Starfire	826mm	1.08"	2.17"	C-5 - 5"	1250	1.64*	3.28+ (1.5")
12cm ED	1006	1.32	2.64	C-8 - 8"	2000	2.62	5.25+ (2.5")
5" Starfire	1045	1.37	2.74	C-11 - 11"	2800	3.67*	7.35+ (3.5")
5"f12 S.P.	1045	1.37	2.74	C-14 - 14"	3910	5.13*	10.26+ (4.5")
5.1" EDT	1045	1.37	2.74	<u>Meade Instruments</u>			
6" Starfire	1415	1.86	3.71	2080 - 8"	2000	2.62*	5.25+ (2.5")
6"f12 S.P.	1800	2.36	4.72	2120 - 10"	2500	3.28*	6.56+ (3.0")
7" Starfire	1665	2.19	4.37	<u>Questar</u>			
8.1" EDF	1576	2.07	4.14	3-1/2	1280	1.68+*	3.36+~ (1.25")
<u>TeleVue</u>				7	2413	3.17+*	6.33+~ (2.5")
Oracle 3"	563mm	0.74†	1.48	<u>Other typical refractors</u>			
Solaris 2.4"	1750	2.40	†	80mm - 3.1"	900mm	1.18"	2.36"
85	560mm	0.73†	1.5	102mm - 4"	900mm	1.18"	2.36"
Genesis	500	0.66†	1.31	6"f15	2286	3.00	6.00
101	550	0.7†	1.4				
102	880	1.2	2.4				

Table. 1 Examples of calculated prefilter diameters for some of the popular telescope we sell. EFL = Average Effective Focal Length, † = Not Suggested, \* = Off Axis Filter



### III. Field of View as a Consideration

The Sun appears in the sky as an object about 1/2 degree in angular diameter. In order to be able to view the entire disk of the sun in an eyepiece, or image it onto a CCD or film (without "mosaic" composition) one will have to consider the image size provided by the complete system. In order to understand this better consider the following examples:

Configuration A. Company Seven uses our Astro-Physics 13cm (5.1 inch) f8 Apochromat refractor for solar observing. This telescope has a 41.3 inch (1048 mm) focal length. With a 5 inch ERF, the telescope remains f8. To attain a nominal f30 beam we may employ either a 2X Barlow with Extension Tube with a Telecentric beam shaping element to produce an approximate f32 nearly parallel 165 inch/4,192mm effective focal length.

To calculate how our telescope will perform visually, we can use the following two formulas:

$$1. \text{Magnification} = \text{Effective Focal Length of Telescope} / \text{Focal Length of Eyepiece}$$

$$2. \text{Actual Field of View (Degrees)} = (57.3 \times \text{Eyepiece Field Stop Dia. in mm}) / \text{Effective Focal Length of Telescope}$$

Understanding a TeleVue 55mm Plossl eyepiece has a 46.00mm diameter Field Stop (yes we actually measure these things), one can quickly surmise the operating magnification will be 76X. And the Actual Field of View will be 0.63 Degree. This will produce a nice view of the Sun with enough surrounding space to easily accommodate prominences, and nicely compose the disk of the Sun against the black background (or space).

If we choose to use a TeleVue 31mm Nagler eyepiece (82 degree apparent Field of View), then with it's Field Stop of 41.63mm and Magnification of 135 X, we will observe 0.57 Degrees - nearly the Field of View shown by the 55mm Plossl but at 1.8X the magnification!

A less accurate but quick formula for those lacking Field Stop details of the eyepiece would be:

$$3. \text{Actual Field of View (Degrees)} = \text{Magnification} / \text{Eyepiece Apparent Field}$$

In this example the 31mm Nagler should provide a Field of View of 0.61 Degrees. This formula is less accurate in that it does not factor the degree of distortion common to wide-angle eyepieces.

Since the limit of Field Stop diameters is reached at about 46mm, a telescope with an effective focal length of more than 4,200mm can not show the full solar. Photographic and video field of view may be similarly calculated to aid the decision making process.

Configuration B. Again using our Astro-Physics 13cm f8 Apochromat for this example, we may employ a TeleVue 2X "Powermate" lens (a 2X Barlow with Telecentric beam shaping element) to produce about an f17 - 85.3 inch (2,167mm) effective focal length. The Telecentric lens shapes the beam to exit the Powermate with an angle of divergence that approximates a nearly parallel beam, this is quite satisfactory for use with the DayStar filter. And this gives the added advantages of requiring less hardware and extensions on the telescope focuser, and allows us to operate the telescope at lower magnifications to "back off" so to speak on sessions with marked atmospheric turbulence.

Using a TeleVue 55mm Plossl eyepiece in configuration B the operating magnification will be only 39X, and the Actual Field of View will be 1.22 Degrees. This will produce a low enough magnification view of the Sun to diminish some of the adverse distractions posed if the atmosphere is turbulent.

If we choose a TeleVue 31mm Nagler eyepiece (82 degree apparent Field of View), then with it's Magnification of 70 X we will observe 1.1 Degrees - again nearly the Field of View shown by the 55mm Plossl but at 1.8X the magnification. One will choose a higher magnification eyepiece like the TeleVue 22mm Panoptic or 22mm Nagler to show a closer view of the full disk of the Sun.

#### IV. Installing the DayStar Filter

1. The DayStar filter may be attached on to the telescope focuser. Be aware that certain telescope optical tubes (particularly Newtonian designs) place the focuser where there may not be enough "back focus" to accept accessories such as the DayStar system. This is done to minimize the deleterious effects of using a larger secondary mirror. This may require that you to employ a Barlow lens to project the image out farther, or reposition the telescope primary mirror closer to the secondary mirror.

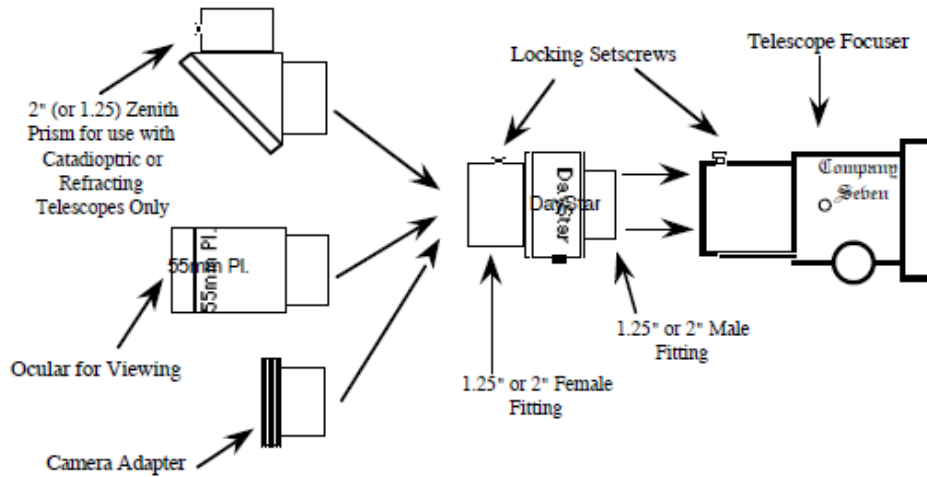


Illustration 9: Installation of DayStar Filter onto telescope focuser.

Refracting telescope optical tubes are usually manufactured to a length that anticipates attachment of a variety of accessories onto the telescope. This may require use of an extension tube between the focuser and the filter body to achieve proper focus. Most suggested variations are shown in the illustrations No. 8, 9, and 11.

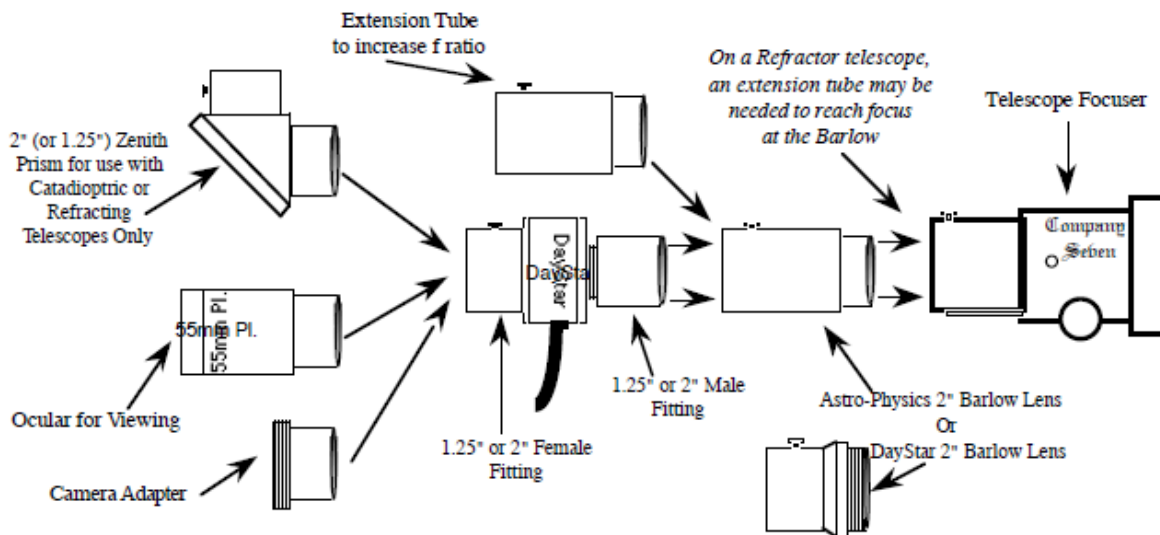


Illustration 10: Installation of DayStar Filter with Barlow (Teleneegative) Lens onto telescope focuser.



If the filter is to be used on a telescope with an off axis ERF then a flange must be installed that incorporated a specific degree of wedge to offset the field curvature encountered in the off axis filtered telescope. The filter body must be rotated so that the wide portion of the wedge corresponds to the position of the off axis ERF. It does not matter if these are at 12 o'clock, 3 o'clock, etc. as long as both index features are at the same position.

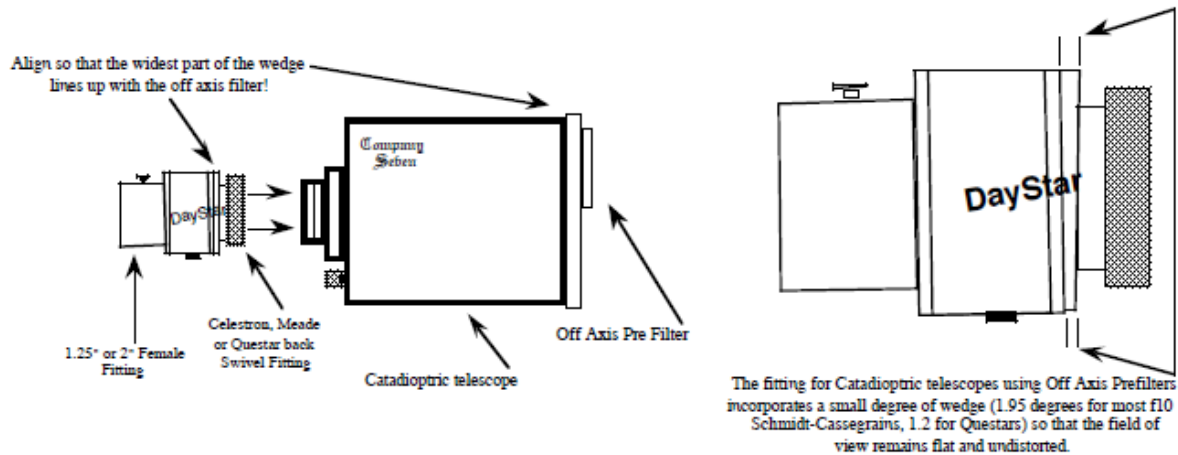


Illustration 11: (Above) Installation on telescope with off axis filters is shown.

A flange with wedge is mandatory for use with an off axis ERF. No wedge is required for on axis ERF. Since the degree of wedge may vary from one off axis filtered telescope design with another, consult with Company Seven prior to moving a filter from one off axis filtered telescope to another telescope.

Use of the Astro-Physics Barlow & Telecentric Lens

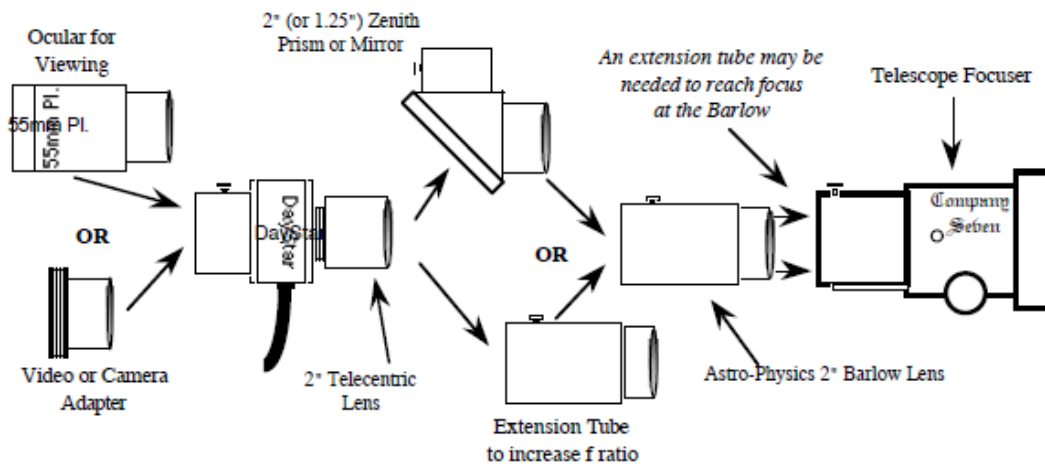


Illustration 12: Installation of DayStar filter using Astro-Physics Telecentric and Barlow Lenses.

If a 2 inch diagonal is to be used then it should be placed ahead of the DayStar Filter, directly into the 2 inch Barlow (or extension tube) and secured at this time. Never place the diagonal behind the DayStar filter with the Telecentric lens in place. If the 2 inch diagonal is not used, then insert the Astro-Physics extension tube (to add projection from the Barlow) into the Barlow lens.

## V. Placing the DayStar Filter Into Service

1. Set up the telescope, Polar Align the mount, and then turn the telescope tracking clock drive "ON". If the drive is so equipped set the drive corrector to track at the "Solar Rate".
2. Install the telescope onto the mount, and adjust balance anticipating the loading of accessories. **Be careful to keep a lens cover in place, or position the tube assembly so that the telescope does not point to the Sun.**
3. **If the telescope has a finderscope, then completely cover the finder objective lens.** The Questar finder may have its own solar filter, dial it into place. This will preclude the possibility that someone may accidentally view through the finder at the Sun. It is also possible that the finder telescope optics may be damaged by unfiltered exposure to the Sun.
4. Position the telescope optical tube so that it is pointing upward, but not directly at the Sun.
5. Lock the Mount Clutches (R.A. and Decl.) to prevent the unbalanced telescope from swinging out of control during set up.
6. Remove the telescope objective lens cover. Slip or thread the DayStar ERF over the front of the telescope. Some care should be taken that the felt spacers that may line the inner lid of the ERF are not dislodged or otherwise damaged. Rather than pushing the filter onto place we suggest that a rotating motion (clockwise and counterclockwise) be used to slide the ERF into place. The fit should be firm to prevent the filter from falling off, but should not require excessive force to place or remove it. You may add or shave some felt to alter the fit.
7. Attach the visual or photographic accessories to the DayStar filter. Then attach the filter onto the telescope focuser. **Company Seven suggests use of a strap to prevent the DayStar filter from falling to the ground if someone accidentally turns the wrong knob; this strap may be attached from the filter to the finderscope.**
8. **If using the ATM or UNIVERSITY H-alpha filter model: ROTATE THE KNOB ON THE OVEN CONTROLLER TO THE DIAL SETTING SUGGESTED ON THE FIRST PAGE OF THIS OPERATING MANUAL. DO NOT EXCEED THE PEAK RATED SETTING UNDER ANY CIRCUMSTANCE!**
9. Establish a reliable power supply and plug the DayStar filter into the power supply. The filter oven will require time (15 to 30 minutes) to attain proper operating temperature. This time will vary with the difference between ambient temperature and the nominal 48 degrees C provided by the filter oven.
10. The easiest way to find and center the Sun in the eyepiece or accessory field of view is to point the telescope up and towards the sun. Observe the shadow cast onto the ground by the telescope, and adjust the telescope until the shadow cast by the telescope covers the smallest area. This should put the sun very close to if not directly in the field of view of the telescope.
11. Gradually focus the telescope looking through the eyepiece. When optimum focus is achieved, you may have to lock the focuser to prevent the weight of the DayStar filter pulling the drawtube out of focus.

As the filter oven warms up to the nominal temperature, you may find it interesting to observe the sun as the filter's pass band moves through the blue wing of the H-alpha. The chromospheric network and prominences will become visible, and will gradually change their appearance. As the filter goes "on band" then the solar features will be revealed at maximum contrast.

Company Seven suggests you acquire an observing hood, or at the least a wide brim hat or baseball cap to cut the glare and distraction from the eyepiece as you observe the Sun. This will dramatically increase the comfort you experience, and the details you can see.

## VI. Application Notes

### Brief Notes About Easy Polar Alignment for Solar Observing

This is a quick and dirty solution for those who want to polar align a telescope equatorial mount during the day and is unsure of how to find true North. A magnetic compass, and a level are all that is needed.

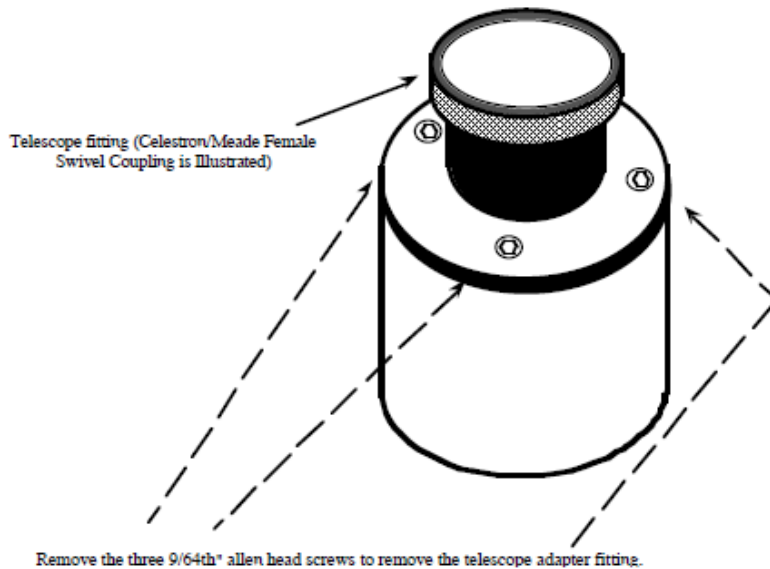
1. Set the telescope mount so that the Declination (DEC) axis setting indicates 90 minus your latitude. For example Washington, D.C. is at about 39 degrees, and so we'll set the mount to read 51 degrees.
2. Lock the DEC axis and adjust the latitude of the mount until the tube is level; a level may be placed onto the tube.
3. Unlock the telescope tube, set it to 90, then move the mount left or right until the polar axis lines up with Polaris, or magnetic north on the compass.
4. Magnetic North varies east or west of true north depending on your location. One can do better to factor in the variance (Magnetic Deviation). For example, Washington D.C. is now about 11 degrees west. This information is readily found in local topographic or air charts, or on the Internet.

### Use of A DayStar Filter on More than One Telescope Design

DayStar filters may be used with more than one telescope without changing hardware if:

- a. the filter is to be used on a similar design telescope such as on a Celestron C-8 and a C-11 with off axis ERF incorporating a similar degree of wedge Flange to offset the field curvature encountered in the off axis filtered telescope. In a case such as this there is no need to change the fittings, although a different prefilter will probably be required.
- b. if the filter is used on any telescopes which use an on-axis (full or partial aperture) ERF.

### Changing DayStar Flanges



Customers may purchase the required DayStar filter flanges and associated fittings from Company Seven.

Three 9/64th inch Allen head screws holds each flange in place. These may be removed and the correct flange installed. Be sure the screws are each only hand tight.

It is suggested that to minimize the inconvenience, the customer retain a 2 inch or 1.25 inch female accessory fitting on the filter and change only the telescope coupling.

Illustration 13: DayStar Filter Flange Fitting.



## Notes on Using the DayStar H-alpha Filter For Photography

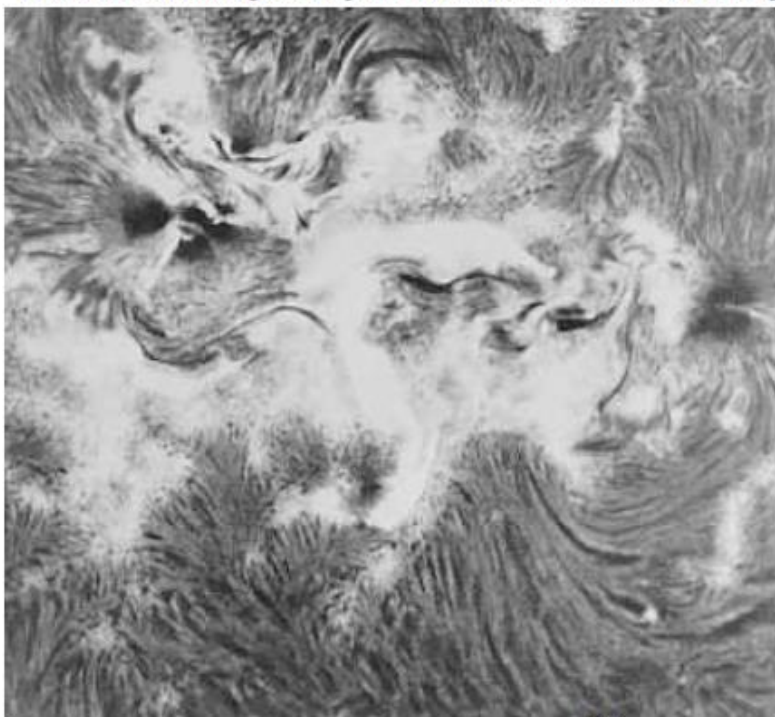
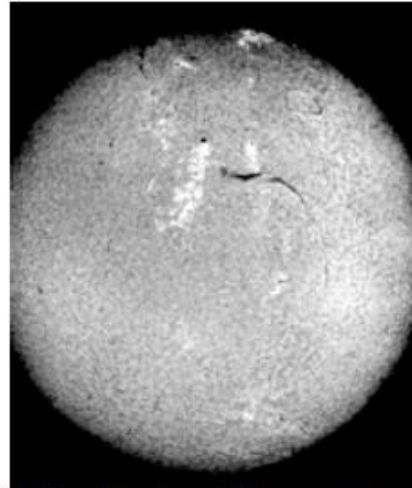
A film camera or a CCD video system may be attached to the DayStar filter to produce Filtergrams. The camera of choice is a 35mm Single Lens Reflex (SLR), preferably one with interchangeable finder and focusing screen (Nikon F3 or F4, Olympus OM-1, etc.) or a Digital camera. Illustrations 9, 11 and 12 of this manual illustrate where to place the eyepiece, an optional 2" camera adapter may be attached in place of the eyepiece.

In order to facilitate obtaining a good focus we suggest the use of a bright clear focusing screen such as that recommended by the camera manufacturer for photomicrography. After focusing the telescope through the camera viewfinder, lock the telescope focuser drawtube (if so equipped). Then lock the camera mirror in the "up" position to reduce the possibility of mirror travel causing vibration during the exposure. The camera meter may be used to set the shutter speed, or one may prefer to bracket and take several exposures; some faster and some with slower shutter speeds. To have a higher degree of success, it is suggested that the focus positions be bracketed - varied slightly in and out of what appears to be nominal.

To trigger the camera a remote control or cable release should be used. If so equipped the camera self timer release mechanism may be used to trigger the exposure when the atmosphere is exceptionally steady.

Atmospheric turbulence may show as regular or periodic "mirage" blurring details. Therefore, while the mirror on the camera is locked up, a second telescope may be employed (with a safe solar filter) to monitor the atmosphere as it passes across the Sun's image. When the "period" of the turbulence is at its lowest, then the photo may be triggered.

A good film for high resolution photography of the Sun is Kodak 2415 Technical Pan, a fine grain black and white negative film with good dynamic range. A good exposure time to begin with (on an f30 system) is about 1/30th second; this is good for prime focus solar disk detail. A slower speed such as 1/2 second may result in



washed out detail on the solar disk, but it will reveal prominences and solar disk edge details better. Technical Pan is best developed in Kodak "D-19" developer for approximately 4 minutes at 1:1 dilution, 68° F. You may wish to adjust this as your experience indicates to vary the degree of contrast. For printing the negatives, a #4 or #5 grade of paper in a high gloss finish will show the best detail.

The DayStar Filter images may also be recorded with a video camera. Since there are so many technical concerns it is best to contact Company Seven for specific advice. However our basic advice is to select a high-resolution black and white or color video camera with at least a 2/3 inch chip (for the widest field of view), with controllable electric shutter, and interchangeable lens ability.

## Calculating Size of the Sun's Image

In order to help one predict what format of film or CCD to employ, and determine the approximate coverage of the Sun on the respective format. The formulas to derive Sun's size are:

$$\begin{aligned}h &= (\text{Theta} \cdot F) / K \\ \text{Theta} &= K \cdot (h / F) \\ F &= (K \cdot h) / \text{Theta}\end{aligned}$$

- $h$  = the linear height in mm of the image at prime focus of an objective or a telephoto lens  
 $\text{Theta}$  = the object's angular height (angle of view) in units corresponding to  $K$   
 $F$  = the effective focal length (focal length times Barlow magnification) in mm  
 $K$  = a constant with a value of 57.3 for  $\text{Theta}$  in degrees, or 3438 in minutes of arc, or 206265 for seconds of arc (the number of the respective units in a radian)

The first formula yields image size of the Sun as approximately 1% of the effective focal length ( $\text{Theta} / K = 0.5 / 57.3 = 0.009$ ).

The second formula can be used to find the angle of view ( $\text{Theta}$ ) for a given film frame size ( $h$ ) and lens focal length ( $F$ ). For example: the 24 mm height, 36 mm width, and 43 mm diagonal of 35 mm film yields an angle of view of 27 degrees, 41 degrees, and 49 degrees for a 50-mm lens.

The third formula can determine effective focal length ( $F$ ) required for a given film frame size ( $h$ ) and angle of view ( $\text{Theta}$ ).

## VII. Maintenance of the DayStar Filter

The DayStar filter body should never be disassembled for any reason. This will void the warranty, and will result at the least in misalignment, if not severe damage to the filter. Periodically inspect the filter. One technique is that while observing with the system in place, rotate the filter body only - contaminants observed to move while the filter rotates would indicate there is some reason to take further action with the filter.

The best cleaning practice is to prevent the filter from accumulating dust or other contaminants. Store the filter with covers on both ends, and or in a sealed container. The container should be stored in a dry, cool area; it is advised that a desiccant packet be stored in this container with the filter to help to preclude Fungal activity.

Keep the exterior clean by wiping it with a soft, lint-free cloth. Pay special attention to insure the fittings on the telescope and the filter are kept clean. If dust appears on the filter elements, a bulb aspirator may blow these particles off; do not use "Dust-Off" or similar compressed gas cans; simply use the large bulb aspirator. Should a smudge appear, it may be cleaned with alcohol and a soft tissue or sterile white cotton ball or swab.

If simple cleaning efforts fail then please return the unit for service to either Company Seven, or to DayStar.

## VIII. Warranty of the DayStar Hydrogen-Alpha Filter

Used as directed, the DayStar Hydrogen-Alpha filter is guaranteed for TEN (10) years from date of delivery from Company Seven. Should the filter become inoperative due to optical or electronic failure, DayStar or Company Seven will repair the filter, or replace it at our discretion with an equivalent filter at no cost to the customer.