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Fluorite Doublet Apochromat

SKY 90

INSTRUCTION MANUAL

TAKAHASHI

Thank you for purchasing the Takahashi SKY-90 fluorite doublet Apochromatic refractor. This highly portable instrument is the most compact apochromat in production. In order to use the SKY-90 to the limit of its capabilities, carefully read this manual and familiarize yourself with its parts and their functions before using the instrument.



WARNING

DO NOT UNDER ANY CIRCUMSTANCES DIRECTLY VIEW THE SUN. USE THE APPROPRIATELY DESIGNED FULL APERTURE FILTER MADE WITH HIGH QUALITY GLASS THAT REFLECTS 99.95% OF THE LIGHT AND HEAT. FAILURE TO DO SO COULD CAUSE INSTANT BLINDNESS. COVER THE FINDER WITH AN OPAQUE COVER TO PREVENT ANY LIGHT FROM COMING THROUGH. AN UNCOVERED FINDER CAN ALSO CAUSE SERIOUS DAMAGE TO THE EYE. KEEP CHILDREN AWAY FROM THE TELESCOPE DURING DAYTIME.



CAUTION

- When placing the tube assembly on to an equatorial mount, be careful to balance the tube in the saddle. This will prevent injury to fingers and will prevent it from falling to the ground.
- Always lay the tube assembly on a completely flat surface that totally supports it to protect it from damage.
- Keep the tube assembly out of the Sun and never be left in any environment such as a hot automobile or any other enclosure where the temperature will exceed 75° F. Otherwise, the tube assembly could heat up, causing lens damage.
- Great care should be taken during focusing.

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Specifications

Optical System	Fluorite Doublet Apochromat
Effective Aperture	90mm ϕ
Focal Length [Prime Focus]	500mm
Focal Ratio [Prime Focus]	5.6
Resolving Power	1.29"
Limiting Magnitude	11.5
Light Gathering	165x
Effective Focal Length [w/Extender-Q] ..	800mm
Effective Focal Ratio [w/Extender-Q] ...	F/8.9
Effective Focal Length [w/Flattener-Reducer]	407mm
Effective Focal Ratio [w/Flattener-Reducer]	F/4.5
Image Circle [w/Flattener-Reducer]	45mm
Lens Shade	Retractable
Tube Length w/Shade Retracted	370mm
Tube Diameter	95mm
Total Weight of Main Tube	3.2kg [7.05lbs]

Tube Assembly Layout

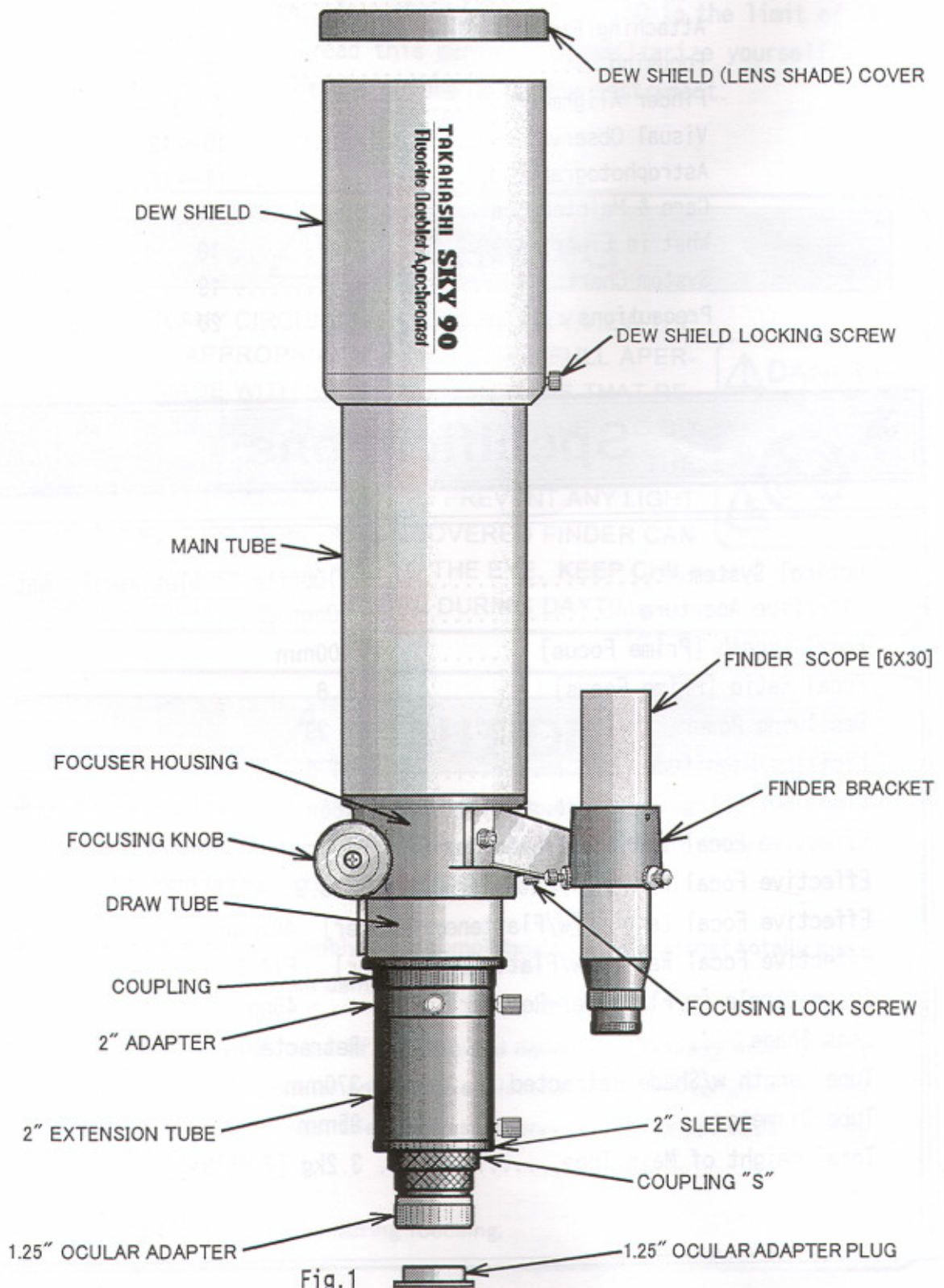


Fig.1

Attaching The Finder And Bracket

A 6x30 finder scope is originally attached to the Sky-90. If necessary, a 7x50 finder scope can be attached in place of the 6x30. The following instructions are for the case when the 7x50 is used.

◆ Attaching The Finder Scope

Place the finder bracket on to the holes in the focuser housing and attach it with the two cap bolts provided. Make certain that the sides of the bracket are parallel to the sides of the tube assembly. Failure to do so will make finder alignment more difficult. A cap screw covers the illuminator hole. Refer to Fig.2 & Fig.3.

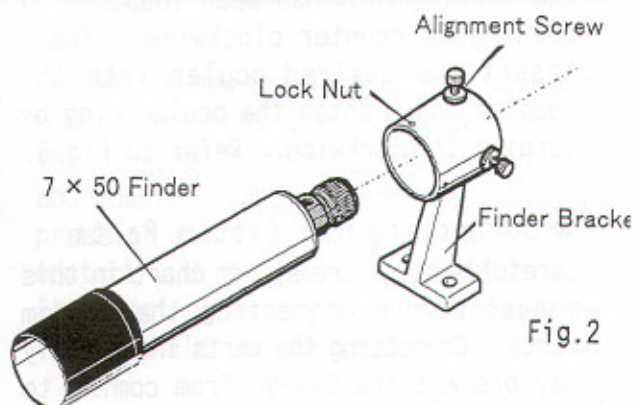


Fig.2

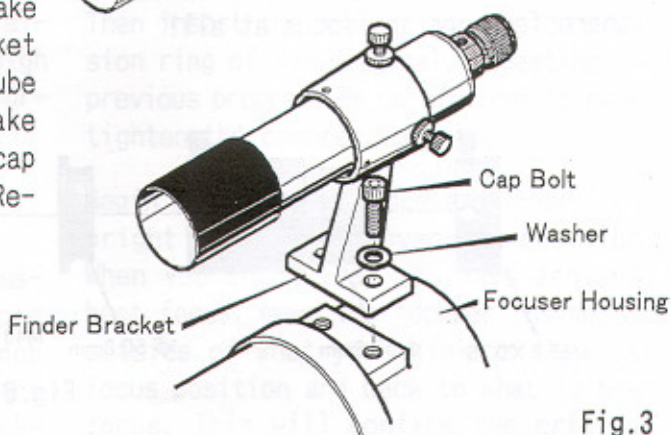


Fig.3

◆ Attaching Tube Assembly To The Equatorial Mount

Place the tube holder onto the top of the Dec. assembly and align the holes in the tube holder with the holes in the Dec. assembly. Attach it with with two cap bolts provided for this purpose. This tube holder can be used with all Takahashi mounts. Refer to Fig.4.

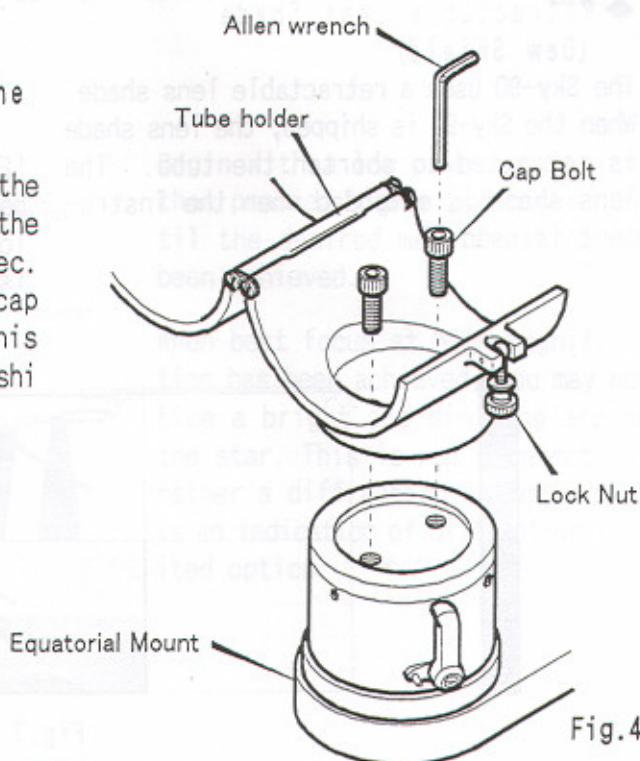


Fig.4

◆ Attaching Oculars

Remove the ocular adapter cover after the locking ring has been loosened by turning it counter clockwise. Then, insert the desired ocular into the adapter and tighten the ocular ring by turning it clockwise. Refer to Fig.5.

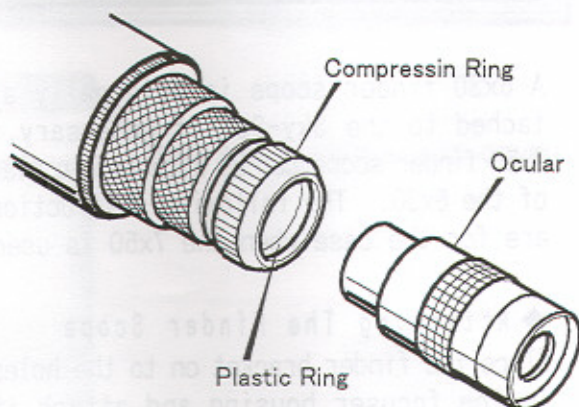


Fig.5

◆ Connecting The System Parts

Carefully study the system chart in this manual before connecting the system parts. Connecting the parts incorrectly may prevent the Sky-90 from coming to sharp focus or any focus at all!

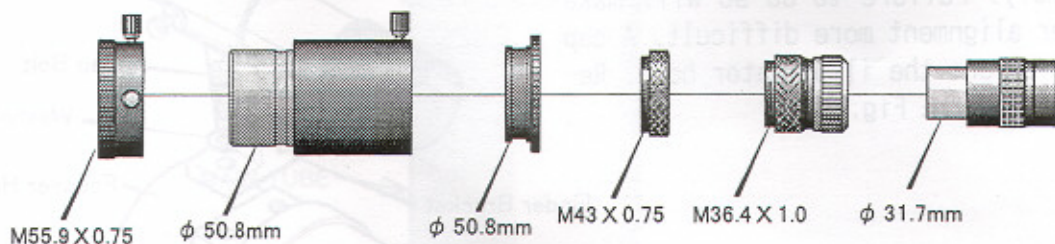


Fig.6

◆ Retractable Lens Shade (Dew Shield)

The Sky-90 uses a retractable lens shade. When the Sky-90 is shipped, the lens shade is retracted to shorten the tube. The lens shade is extended when the instrument is used.

1. Remove the lens shade cover.
 2. Loosen the locking screw.
 3. Extend the lens shade.
 4. Lightly tighten the locking screw.
- [For the most part, the lens shade will be moved when the locking screw is slightly loose. Use your judgement when the screw is tightened, if necessary.]

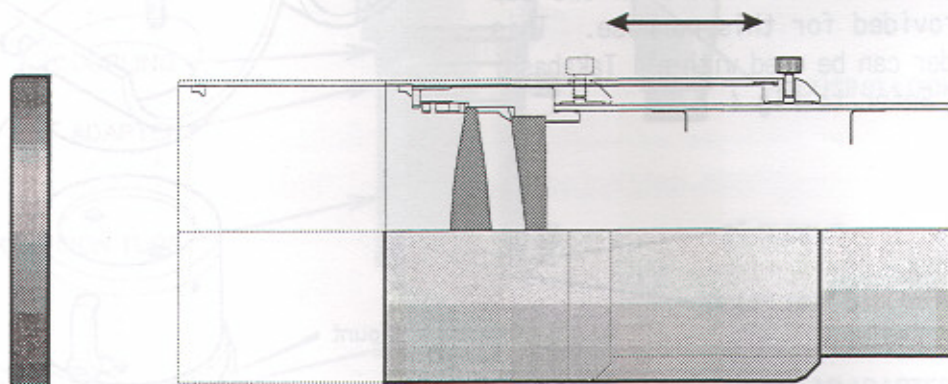


Fig.7

Focusing

After inserting the ocular into the telescope, it is necessary to achieve the best possible focus. Remember the atmosphere will limit the highest magnification that can be used on any given night. Using the lowest power ocular; focus the image and then increase the magnification by using shorter and shorter focal length oculars until the desired magnification is reached. This procedure allows the centering of an object at high magnification. Please familiarize yourself with the following.

◆ Focusing System

The SKY-90 uses a rack-and-pinion focusing system. This system permits rapid focusing. By turning the focusing knob clockwise the focuser will move out and by turning the focuser knob counter-clockwise the focuser will move in. Refer to Fig.8.

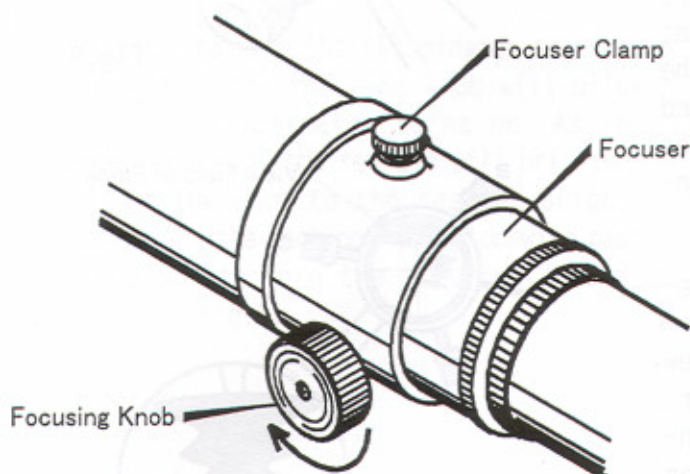


Fig.8

Remove the dew shield end cover and eyepiece plug from the telescope. Insert the diagonal into the compression ring and adapter. Carefully tighten the compression ring until it begins to make contact with the barrel of the diagonal. It is not necessary to overtighten the ring to hold the diagonal.

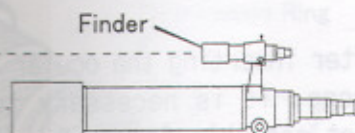
Then insert the ocular into the compression ring of the diagonal, repeating the previous process. Be careful not to overtighten the compression ring.

Begin the focusing process by choosing a bright star in a convenient position. When you think that you have achieved best focus, move the focuser inside and outside of what you think is the best focus position and back to what is best focus. This will confirm the critical procedure.

Begin with a low power ocular and then proceed higher and higher until the desired magnification has been achieved.

When best focus at high magnification has been achieved, you may notice a bright and dim ring around the star. This is not a defect but rather a diffraction pattern which is an indication of diffraction limited optics.

Finder Alignment



A finder is a useful tool. It permits the precise centering of an object in the field of view. The 6.3° field of view allows the easy centering of an object to be viewed or photographed.

The Takahashi finders use an interrupted crosshair which is designed to allow the easy centering of an object to be photographed or observed. The wide field of the finder makes the finding of an object easier, therefore, it is important that the finder and the telescope be in alignment. The following procedure can be used to align the finder.

◆ Alignment Procedure

1. Place a low power eyepiece in the telescope and center a bright star in a convenient part of the sky. Do not forget to engage the motor drive to keep the star centered. If this procedure is done in daylight, use an object that is at least one mile away. Loosen the lock nuts on the finder bracket and slightly move the star to the center of the field using the adjusting alignment screws.
2. Then use a higher magnification eyepiece and repeat the procedure by centering the object in the field of view of the telescope and then the finder. Continue this process until the highest possible magnification has been used.

Finally, tighten the lock nuts and locking screws. If the object moves slightly, adjust alternately tighten and loosen the locking nuts until the object stays in the center.

◆ Adjusting Screw Procedure

1. Turn all the lock nuts until they reach the head of the alignment screws.

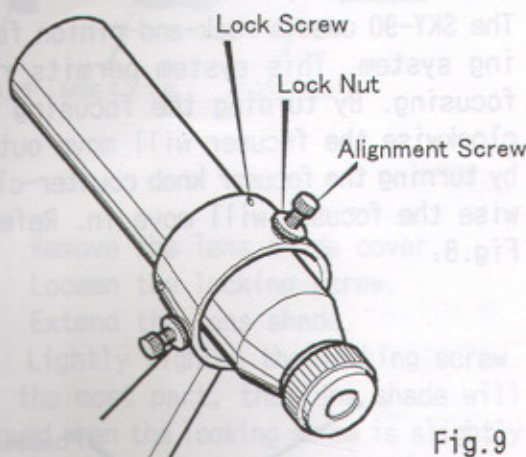


Fig.9

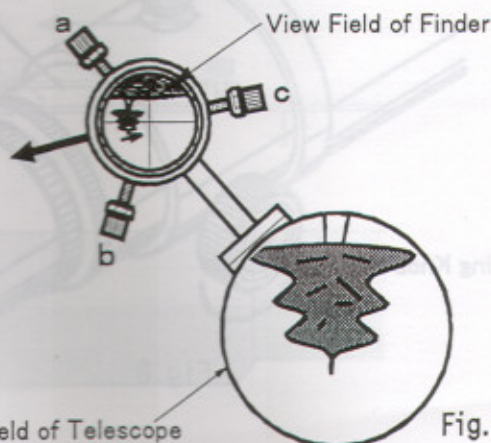


Fig.10

2. In order to move the crosshair in the direction of the arrow, first loosen screw (a) and tighten (push) the finder with screw (c). This procedure will move the crosshair in the desired direction. The top of the finder will move in the opposite direction and the object will move in the direction of the smaller arrow. Refer to Fig.9.

3. In a similar fashion the direction of the movement of the finder is made by adjusting the three screws.

Learn the relationship between the movement of the three adjusting screws. If the finder cannot be moved in the desired direction, loosen the locking nuts.

◆ Reticle Illuminator [Optional]

The 7x50 finder has provision for an optional reticle illuminator.

If an illuminator will be installed, remove the cap screw at the end of the finder and install the reticle illuminator. The illuminator makes the centering of dim objects easier.

In order to turn the illuminator on, turn the knob clockwise. The knob will click when the illuminator turns on. As the knob is turned, the reticle will brighten. Adjust the knob to the desired brightness. Turn the knob counter-clockwise past the click to turn the illuminator off. Refer to Fig.11.

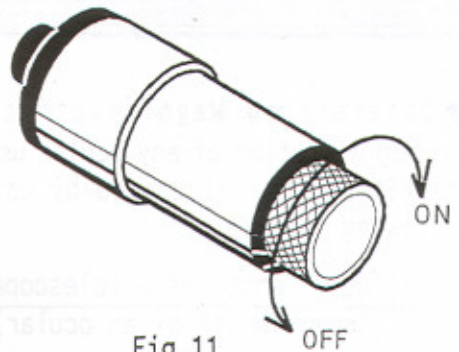


Fig.11

◆ Replacing The Battery

Before changing the batteries in the illuminator, please be certain to turn it off. Unscrew the battery holder as shown in Fig.12. Remove the old batteries and insert new one after they have been wiped with a clean dry cloth. Check the polarity of the batteries before inserting them into the holder. Use two silver [V76-PK] or equivalent batteries.

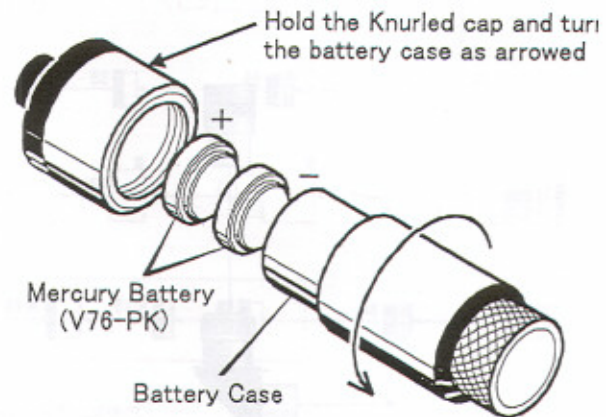


Fig.12

Visual Observation

◆ Determining Magnification

The magnification of any ocular used with the FSQ can be calculated by using the following formula.

$$\frac{(\text{focal length of a telescope})}{(\text{focal length of an ocular})}$$

Therefore, the shorter the focal length of the oculars used, the higher the magnification produced.

During nights of good seeing, the SKY-90 can be used at a magnification of 100x per inch and on nights of exceptional seeing 120x or more can be used. These rare nights of exceptional seeing will reveal fine planetary filaments and small craterlets on the Moon. At the lower end, using a magnification of 10X per inch will produce breathtaking, ultra high contrast views of galaxies, nebulae and comets.

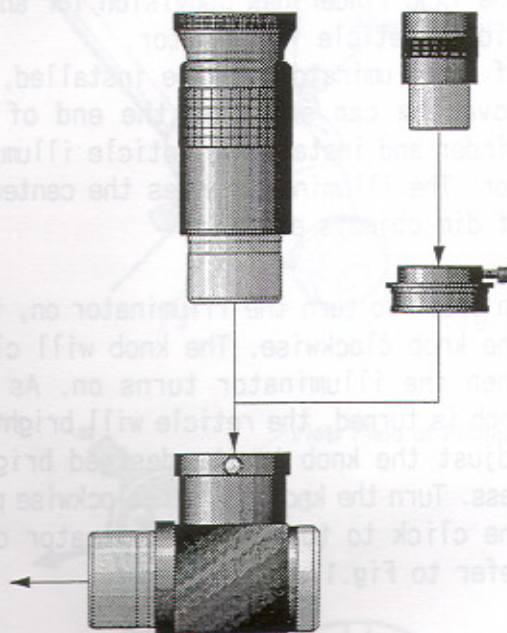
◆ Compression Ring Star Diagonals

Takahashi supplies each SKY-90 set [telescope w/mount] with a 90° compression ring 1.25" diagonal. The compression ring centers the ocular and makes the optical axes of the ocular and the telescope coincidental.

Set the ocular into the compression ring and carefully tighten the ring. Do not overtighten the compression ring.



1.25" Diagonal prism



2" Diagonal mirror

Fig.13

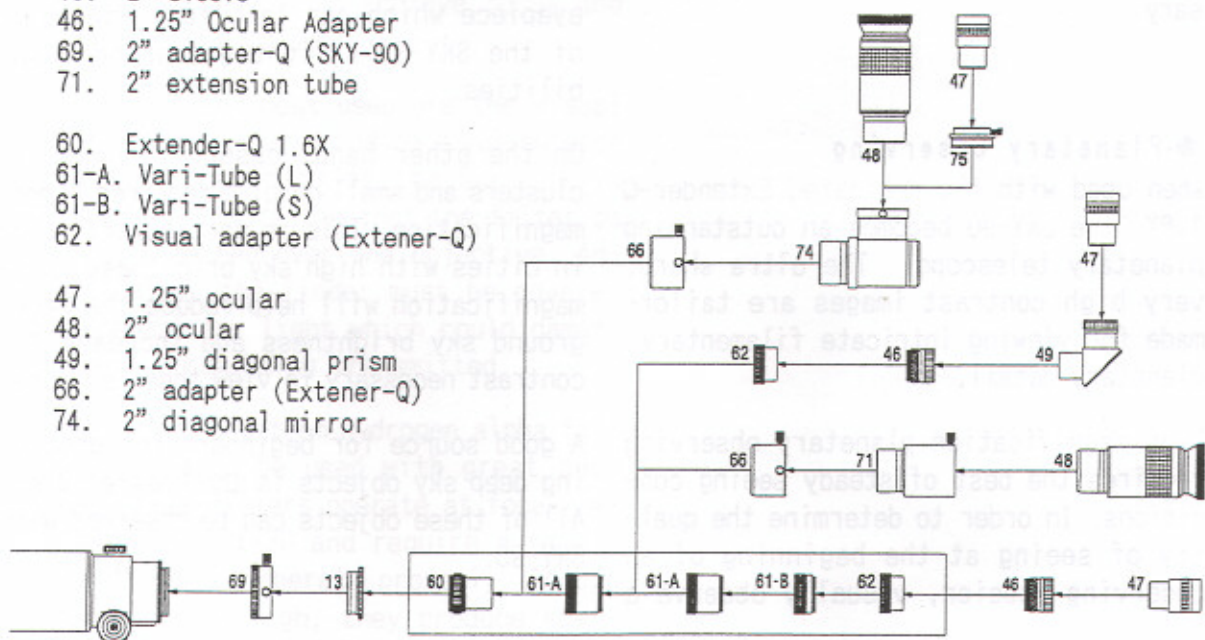
◆ Extender-Q 1.6X

The SKY-90 is a short focus photo/visual astrograph. Nonetheless, due to the very high quality of the optics, the instrument can be used for high magnification lunar and planetary observations.

The Extender-Q 1.6X is designed to increase the focal length sufficiently to produce the higher magnifications necessary for this type of observing. This dedicated extender increases the focal length by 1.6X to 800mm.

When used with the Takahashi LE-5 ocular it produces 160X or 286X if the 2.8 Takahashi High Eye ocular is used. Refer to the chart for the Extender-Q 1.6X.

- 13. 2" sleeve
- 46. 1.25" Ocular Adapter
- 69. 2" adapter-Q (SKY-90)
- 71. 2" extension tube
- 60. Extender-Q 1.6X
- 61-A. Vari-Tube (L)
- 61-B. Vari-Tube (S)
- 62. Visual adapter (Extener-Q)
- 47. 1.25" ocular
- 48. 2" ocular
- 49. 1.25" diagonal prism
- 66. 2" adapter (Extener-Q)
- 74. 2" diagonal mirror



Extender-Q 1.6X System chart

Fig.14

◆ Lunar Observation

The Moon is an excellent object for beginners as well as advanced amateur astronomers. The entire Moon can be viewed at 50X. If the Moon is full, it is best to use an ND96, 58 green, 3N5 filters or variable density polarizer.

Good lunar observing requires some patience. Since the seeing varies from moment to moment, each object should be observed for a period of time to familiarize oneself with the area. Familiarization will allow the observer to see more detail and in the moments when seeing greatly improves, see amazingly detailed views of the lunar surface. Using higher magnification will allow the observer to see smaller details, ray structures, and rilles. Due to the diminished image brightness, filters are not necessary.

◆ Planetary Observing

When used with the dedicated Extender-Q 1.6X, the SKY-90 becomes an outstanding planetary telescope. The ultra sharp, very high contrast images are tailor-made for viewing intricate filamentary planetary detail.

High magnification planetary observing requires the best of steady seeing conditions. In order to determine the quality of seeing at the beginning of an observing session, visually observe a

bright

star at the zenith. If the star is twinkling rapidly, the seeing is poor. It is on those when the star does not twinkle or twinkles very slowly that high magnification planetary viewing can be done. When the seeing is this steady, magnification up to 100x per inch can be used.

Additionally, high quality photos can be made using Fuji Velvia film.

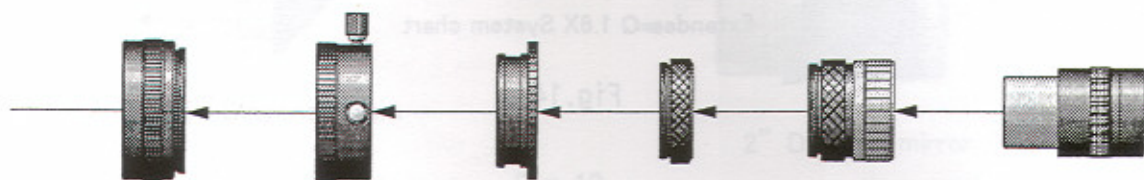
The TCA-4 can be used to achieve the effective focal length of up to f/150 to produce very high quality lunar and planetary photos.

◆ Deep Sky Observing

In general, observing nebulae and star clusters requires a low power, wide field eyepiece which can take full advantage of the SKY-90's light gathering capabilities.

On the other hand, observing globular clusters and small nebulae requires higher magnification. This is particularly true in cities with high sky brightness. High magnification will help reduce the background sky brightness and increase the contrast necessary to view these objects.

A good source for beginners for observing deep sky objects is the Messier list. All of these objects can be observed with SKY-90.



Flattener-Reducer

Fig.15

◆ Solar Observation

The SKY-90 can be used for solar observation when used with a properly designed glass, high quality solar filter that rejects 99.9% of the heat and light. There are three types of these filters that can be used with the SKY-90.

Additionally, the finder must be covered to prevent any direct sun light from damaging the eye. If the finder is used, it is best to use a double layer of aluminized mylar. Though their cost is high, they produce images of solar prominences and surface detail not visible in white light.

The photographic type transmits more light and hence should not be viewed through directly. The image is focused by looking through the finder of the camera for very brief period to achieve focus and for framing purposes.

The second and most used are the visual kind. These filters produce a yellow disk close to the color of the Sun. It is absolutely imperative that the filter be firmly attached over the objective. Additionally, the finder must be covered to prevent any light which could damage the eye, from being transmitted.

Lastly, sub-angstrom hydrogen alpha filters can also be used with great success. These filters operate at focal ratios of over $f/30$ and require a rejection filter to operate properly. Though their cost is high, they produce spectacular images of solar prominences.



Astrophotography

Focus is the most critical part of a fine astrophoto. Once critical focus is achieved, photos can be made. If possible recheck focus to make certain that nothing has changed.

SKY-90 is very high quality F/5.6 astrograph with a large image circle of 45mm ϕ an amazing 6.3° across, which can fully illuminate the photo field of a 35mm SLR camera and usable with a Mamiya 645 as well.

The ultra sharp stellar images produced by the FSQ-106 make it necessary for each photo to be precisely guided. Guiding error will make the pinpoint stellar images become egg shaped. Therefore, a heavy-duty highly accurate mount is needed to properly guide the astrophotos. The Takahashi EM-10USDII is the perfect choice for this task.

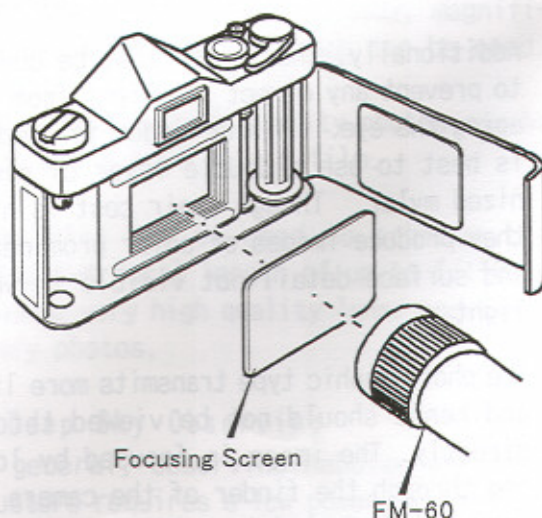


Fig.16

Focusing with the FM-60 focusing microscope and ground glass is shown in Fig.16. Set the ground glass in place with the mat side facing the objective of the SKY-90. Then focus and check for pinpoint focus over the field of view.

◆ Photographing With A 35mm Camera
As shown in Fig.17, a 35mm camera can be attached as show with the CA35 camera adapter and a wide T-mount.

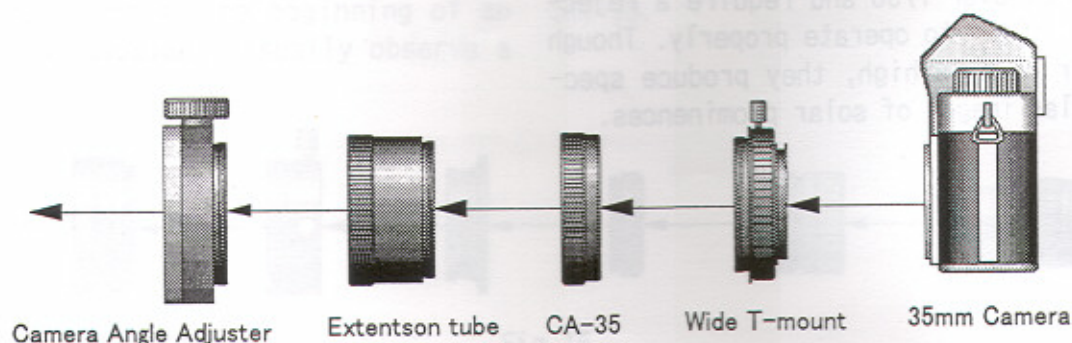


Fig.17

◆ Astrophotography With Flattener-Reducer

The dedicated Flattener-Reducer option-ally available is specially designed for astrophotography. When used, it makes not only the photographic field flat and the focal ratio bright to F/4.5, but effectively corrects various aberrations produced by the objective. It also makes the instrument a wide field and high quality imaging astro camera. As shown in Fig.18, a 35mm camera can be attached as show with the CA35 camera adapter and a wide T-mount.

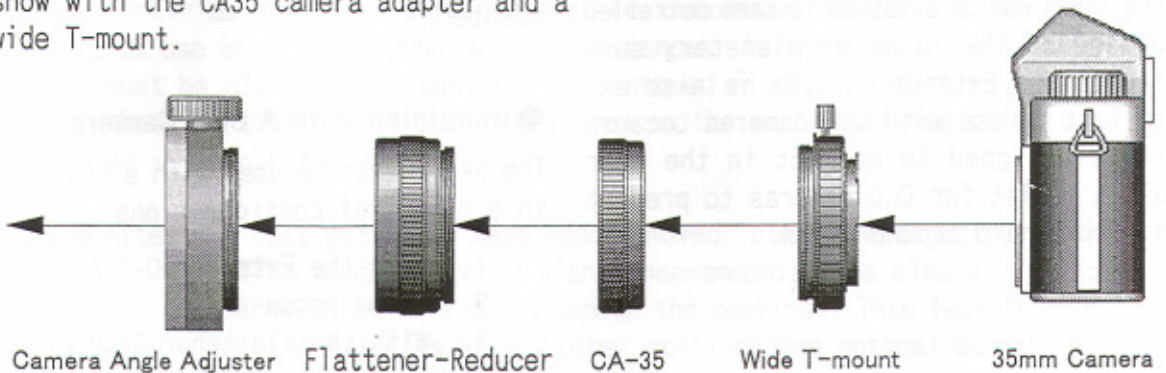


Fig.18

◆ Attching Filters

When a 35mm camera is used with the Sky-90, filters can be attached in two places:

1. a 48mm ϕ can be attached to the wide mount T-ring.
2. a 52mm ϕ can be attached to the camera angle adjuster.

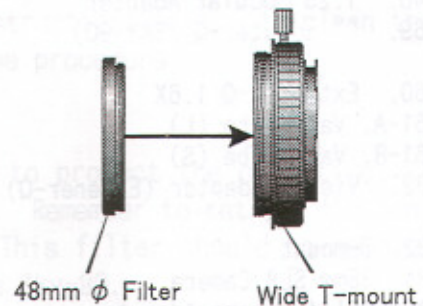


Fig.19

Refer to the illustration Fig.19 & Fig.20.

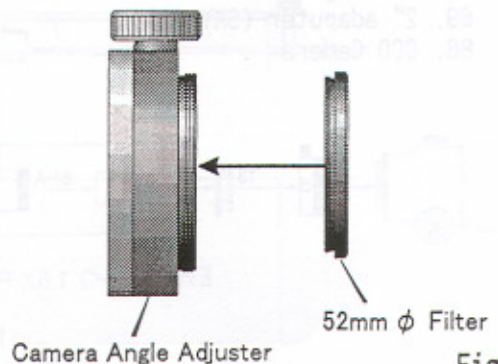


Fig.20

◆ High Magnification Photography

● Astrophotography by the Extender-Q 1.6X

The Extender-Q 1.6x is an extender/corrector so it can be used to make high quality photos of the Moon and planets. If the Extender-Q 1.6x is used by itself the focal length of the instrument is increased by a factor of 1.6x making magnified photos of the lunar and solar discs possible. If higher magnification is desired using ocular projection, the TCA-4 can be attached to make detailed photos of the lunar or planetary surface. The Extender-Q 1.6x is also excellent to use with CCD cameras because it is designed to correct in the near ultra violet for CCD cameras to prevent a purple halo around stars.

● TCA-4 Photography

This is highly sophisticated ocular projection device used to make high magnification photos of the Moon and planets. Using the special ocular adapter provided, ocular projection photos can be taken merely by attaching the TCA-4 over the ocular adapter. The TCA-4 is supplied with a 1.25" adapter and it can be used with the optionally available .965" adapter.

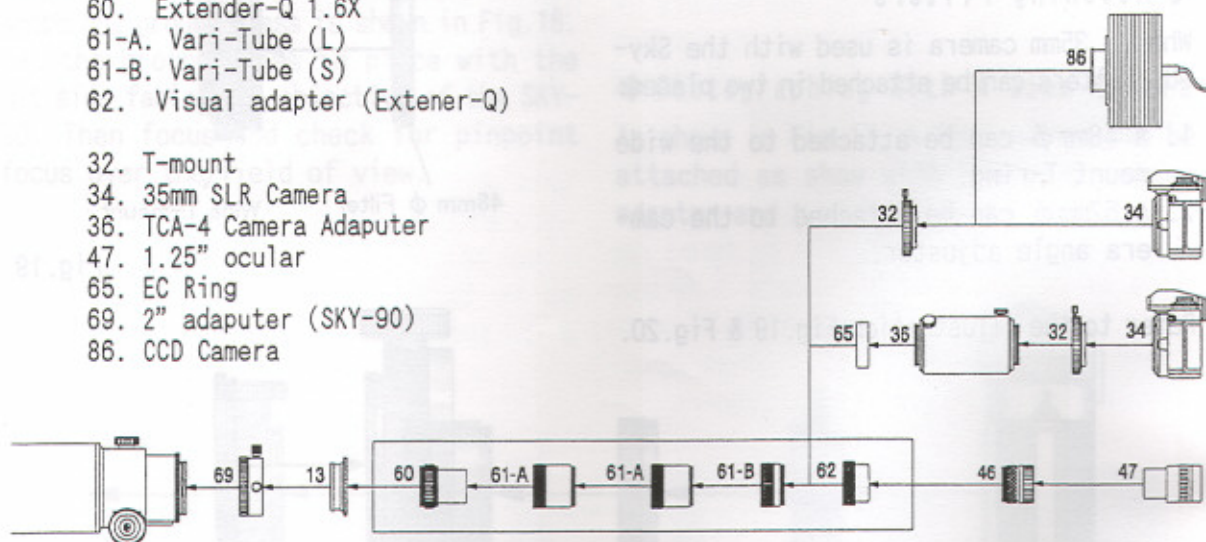
● Imaging With A CCD Camera

The Sky-90 can be used with a CCD camera in a number of configurations.

1. With the Extender-Q 1.6x
2. Prime focus
3. With the Flattener-Reducer

In all these configuration the Sky-90 will produce images with very small steller images into the far infrared.

- 13. 2" sleeve
- 46. 1.25" Ocular Adapter
- 69. 2" adapter-Q (SKY-90)
- 60. Extender-Q 1.6X
- 61-A. Vari-Tube (L)
- 61-B. Vari-Tube (S)
- 62. Visual adapter (Extener-Q)
- 32. T-mount
- 34. 35mm SLR Camera
- 36. TCA-4 Camera Adaputer
- 47. 1.25" ocular
- 65. EC Ring
- 69. 2" adaputer (SKY-90)
- 86. CCD Camera



Extender-Q 1.6X Photo/Visual System chart

Fig.21

Care & Maintenance

- ◆ The SKY-90 has been precisely collimated at the factory skilled optical technicians. Moreover, collimation is maintained by the special design of the lens cell. The design of the cell helps prevent decollimation in normal heavy use. In the even collimation is necessary, contact your local distributor for collimation.
- ◆ During normal use the front of the objective may pick up some dust particles. The dust particles can be removed with a hand blower. Do not use canned air under any circumstances. In the even the objective must be cleaned, all dust must be removed first. Failure to remove these particles will cause scratches on the surface of the objective as it is cleaned.
- ◆ After all dust particles have been removed, clean the objective with a pure cotton swab moistened with a non-ammonia lens cleaner. Using any cleaner with ammonia could damage the coatings. This fact is also true when camera lenses or any other multi-coated optical surface is cleaned.
- ◆ Be certain that the lens shade has been removed before attempting to clean the objective. If you have any questions concerning cleaning, contact your local distributor for instructions on how to clean the objective properly before beginning the procedure.
- ◆ Lens Protector
A 95mm ϕ lens protector is available to protect the objective. It will screw directly into the lens cell. Remember to retract the lens shade before attaching this filter. This filter should be removed when any photographs is taken with the Sky-90.

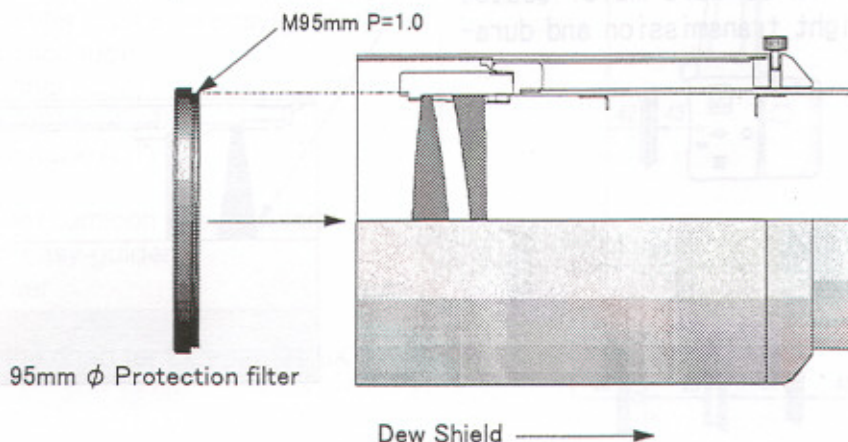


Fig.22

What is Fluorite?

Calcium fluorite (CaF_2) is a naturally occurring crystal. Its very low refractive index makes it the best of materials to use in the manufacture of apochromatic telescopes. Unfortunately, the natural crystal contains impurities and as a result, displays some properties that make it unsuited for use in a telescope.

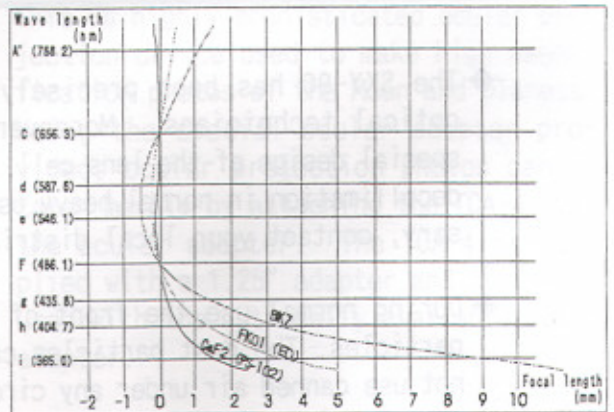


Fig.24

Comparative Diagram (non-coated)

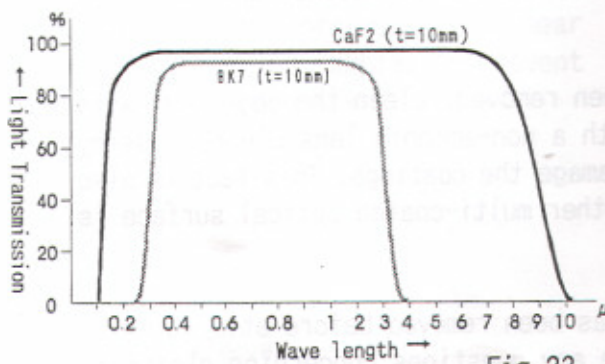


Fig.23

As the diagram shows, the band pass of fluorite of 1000 to over 100,000 angstroms eclipses by many magnitudes that of any optical glass. Additionally, the use of multicoatings further increases light transmission over any ED glass. These features make the fluorite objective the premier photo/visual instruments for deep sky or lunar and planetary applications in their size class.

Now thanks to modern technology, fluorite crystals are grown in an oven. This process produces a totally pure mono crystal structure that does not display any of the unsuitable properties of the natural crystal and has the same very low refractive index. Now, calcium fluorite crystal can be hard multi-coated for maximum light transmission and durability.

When the fluorite instrument is taken out for an observing session, it will take about 30 minutes for the objective to temperature equalize for maximum performance. This fact is also true for any optical system used.

Fluorite Lens

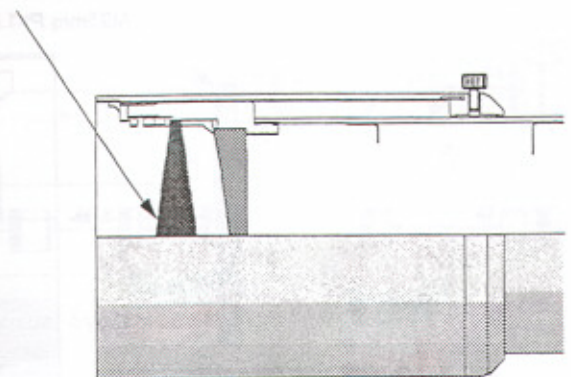


Fig.25

Additional Precautions

- ◆ If possible, keep the telescope away from large temperature fluctuations. If the instrument is brought out from a warm room to cold air, dew may form. Use a hair dryer with the heating element turned off to evaporate the dew.

The same is true when the instrument is taken in and there is dew on the objective. Use the hair dryer with the heating element turned off to evaporate the dew. Or if the room is air conditioned, the dry cool air will evaporate the dew. It is imperative that all dew be evaporated before the Sky-90 is stored away. Place a few packets of desiccant near the objective to keep it dry.

Store the instrument in a cool dry place.

- ◆ When objective is cleaned, it should be done in a cool and dry room.
- ◆ The best amplification device that can be used with the Sky-90 is the Extender-Q 1.6x. It is designed to give the maximum performance when used with the Sky-90 lens which extends out could hit the rear lens of the telescope and cause it to crack.

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