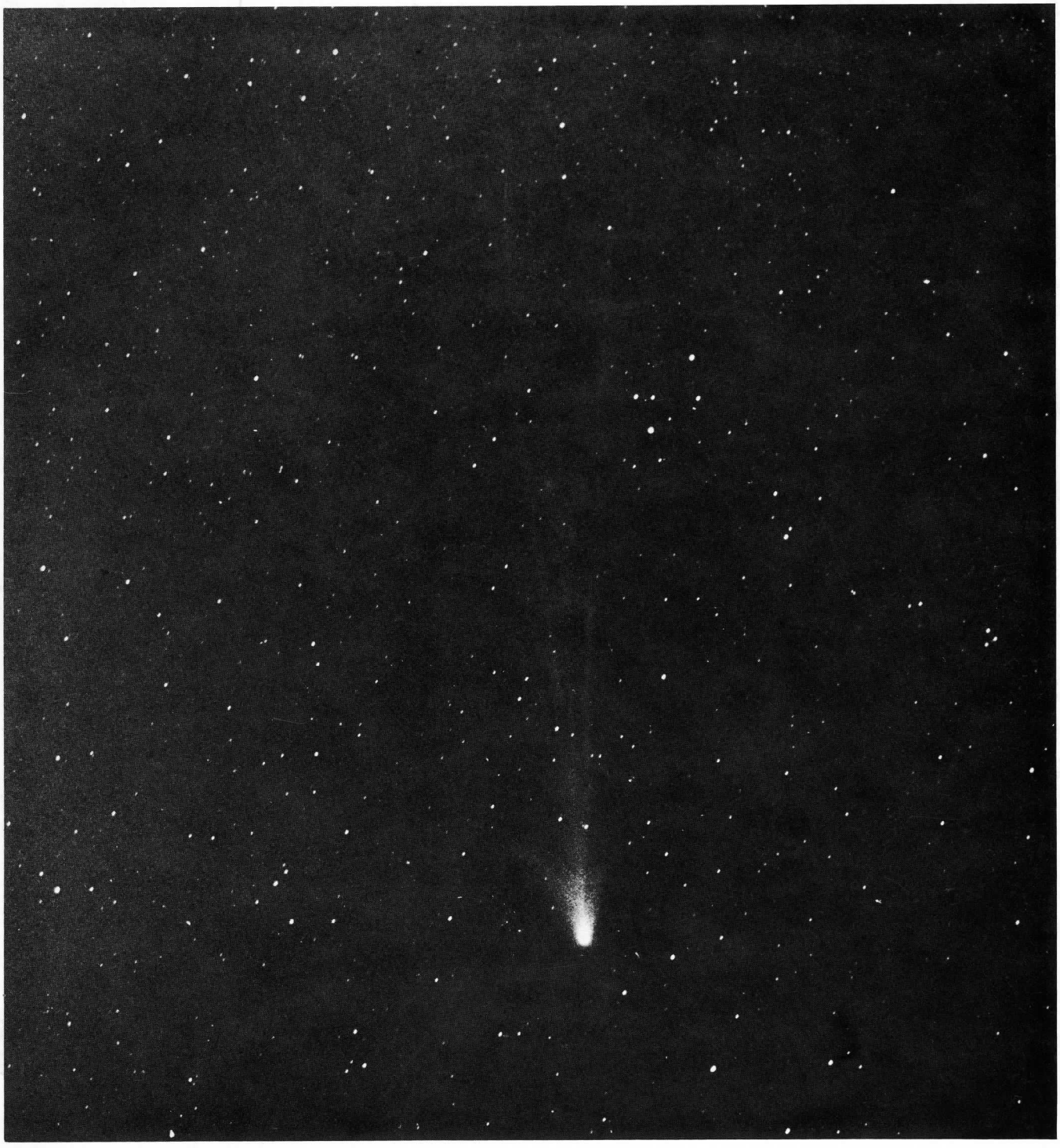
the ASTROGRAPH



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Editor	Robert C. Price
Assistant Editor	Susan K. Price
Contributing Editors	Charles and Margaret Townsend, and John Sanford
Contributors	Greg W. Griffith and Douglas Huston, Michael O'Neal and E. Ken Owen

COVER PHOTOGRAPH

Comet Bradfield

Photographer	G.W. Griffith
Date	March 30, 1974
Telescope	8 inch Schmidt
F No.	1.5
Exposure	5 Minutes
Film	Plus-X
Developer	Acufine
Enlargement	9x
Paper	Agfa #6

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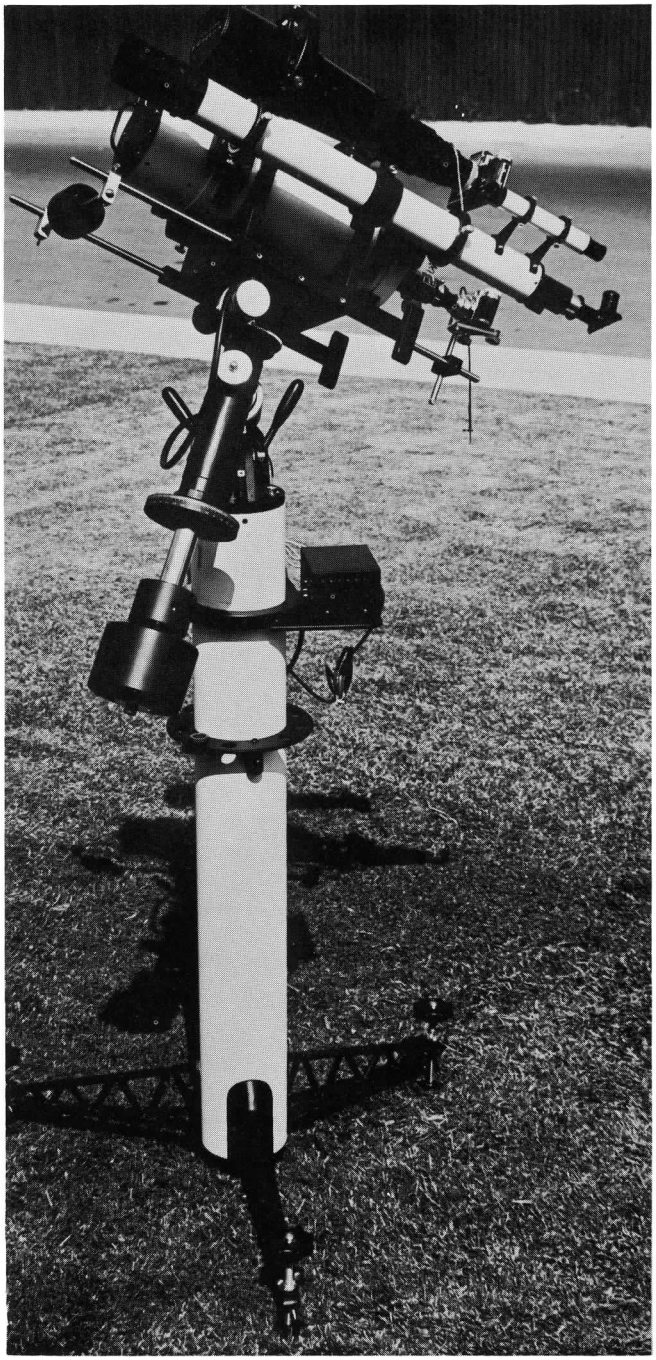
A CUSTOM PHOTO-VISUAL PATROL SYSTEM

Introduction

Without a doubt, areas in which the amateur astronomer can successfully compete with the professional astronomer to make significant contributions to astronomy are somewhat constrained. However, the constraint boundaries include enough "space" and "targets" to keep the amateurs of today and those of future centuries very active in a support role. For example, the orbits of many asteroids are not well known due to both gravitational and non-gravitational effects. Thus, if flybys of these bodies are to be successful, additional positional and orbital data are required to reduce the in-plane distance error between them and the earth at the predicted time of encounter. Many amateurs of today are well-equipped to perform such position measurements and orbit calculations since miniaturized electronic calculators and large aperture, long focal length camera systems are readily available. Furthermore, with respect to novae and comets, the professionals cannot be looking everywhere at once. Neither can they simultaneously search for and analyze all the many different types of astronomical phenomena that are constantly occurring throughout space. Thus, despite the expansion and increased capability of professional observatories and the recent orbiting and landing of sophisticated instrumentation about and on various bodies of the solar system, the amateur will always have the opportunity to discover and contribute knowledge to the scientific community. In particular, the following areas are considered by the authors to lie within the realm of the amateur wishing to execute useful observations and perform productive research: (1) the detection of intragalactic "edge" novae and extragalactic "core" novae, (2) the recovery, discovery, and analysis of comets and asteroids, (3) the photographic analysis of new and old meteor groups, and (4) the study of variable stars.

With these possibilities in mind, the authors undertook the design and commercial fabrication of the custom photo-visual patrol system shown in figure 1. While true that few amateurs can afford such a procedure, it is also true that many of their current or future instruments can be self-modified to incorporate many of the proven design features of the custom system depicted in figure 1. Consequently, in the hope of helping intermediate-level amateur astrophotographers and telescope makers in the update of their existing or planned equipments, or the beginner in the purchase of his first photo-visual system, a description of the construction details and observational usage of our photo-visual patrol system is presented herein.

DESIGN FEATURES



ABOVE: Figure 1 Custom Photo-Visual Patrol System

Specifications for the semi-portable photo-visual patrol system of Figure 1 were submitted for bid during January 1972. On the basis of responses received soon thereafter, Cave Optical Company of Long Beach, California was selected to fabricate the pier and mount assemblies, while C & R Precision Tool Co. of Ventura, California was selected to machine the optics assembly. The optics proper were the responsibility of the authors. Work was begun in March 1972, and the photo-visual system was ready for use in October 1972.

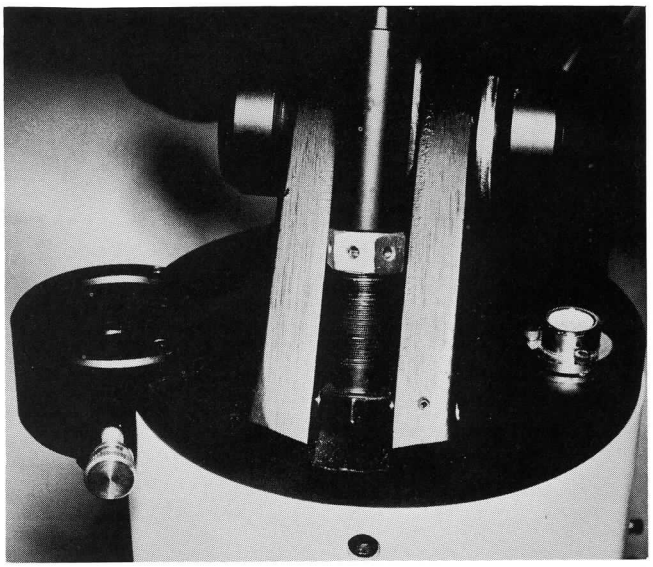
The backbone of the photo-visual system is the aluminum mounting pier. It measures 4'H x 6"OD

x 3/16"T and serves to support the mount and optics assemblies. An internal aluminum ring reinforces the bottom of the pier and prevents deformation due to accidental blows. Three lightweight and detachable (but structurally strong) feet provide support for the pier and its upper load. Each of the wrap-around feet is vertically adjustable over a distance of four-inches via a lockable, knurled handle leveling screw. As shown in Figure 1, each of the feet rests on a removable, large diameter, recessed metal support pad that provides rigid, no-slip support on any reasonably hard surface. The end of each leveling screw is rounded to match a machined indentation in the top of each support pad. A height adjustable, non-mar type accessory tray mounts about the pier, and it can accommodate one dozen accessories. A similar non-mar tray is used to peg-support the transistorized DC/AC inverter drive shown in Figure 1. The drive system is so quiet that a safety toggle switch and a pilot light are required to let the operator know of and control its running period. The pilot light also serves to preclude human collisions with the photo-visual system at dark site star parties.

To accomplish right ascension and declination tracking, two synchronous clutch-drive motors are provided. The non-reversible right ascension motor drive is hand-controlled by a single speed, bang-bang control unit. Either 110 VAC or 12 VDC may be used to power the anti-backlash motor drives. When the 12 V battery of a car is used for field operation, the DC to AC inverter will not run the car battery down even if left on all night.

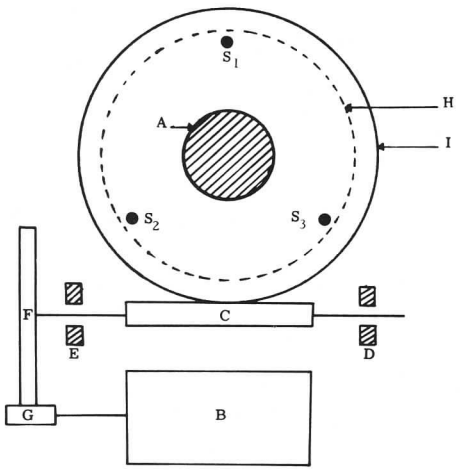
The heat treated, cast aluminum, equatorial tracking mount base is precision machined to snuggly fit into the top of the mounting pier. It is grooved around its diameter so that radially directed allen screws through the top of the pier will retain it when tightened, while permitting smooth no-tilt rotation of the entire loaded mount assembly when loosened. The mount is of the German-type, and as shown in Figure 2, it has lockable fine adjusts for both azimuth and elevation movements. These fine adjusts are a must for long duration astrophotography, because the polar axis of the mount must be aligned to within 2 arc minutes of the true celestial pole if high definition photographs of faint star groups and deep space objects are to be obtained.

After the locks on the azimuth fine adjust controls are secured and the polar alignment effected, the aforementioned Allen set screws lock the grooved base of the mount firmly in place on top of the pier. Similarly, two large handles lock the neck of the mount firmly in place after the elevation controls are secured. This set/lock procedure insures absolute retention of the initial polar setting. A sensitive, spring loaded bubble level is used for initial leveling of the mount base (see Figure 2).



ABOVE: Figure 2 Mount Polar Axis Adjustments

Both the polar and declination axes of the mount are lockable. They each rotate via a spaced-pair of pre-loaded, double race ball bearings for smooth tracking. The sliding counterweights on the declination axis and front portion of the mount craddle permit precise balance to be attained for all parts of the sky when cameras and other accessories are placed on the mount.



$$\text{Drive Rate} = 1 \times \frac{G}{F} \times \frac{C}{I} = \frac{1}{1440} \text{ RPM}$$

KEY

Item	Designation	Specifications or Function
A	Polar Shaft	1.5 inches O.D.(Chrome Plated Steel)
B	Synchronous Motor	1 RPM/5 Watts
C	Worm	1 Tooth Gear Function
D	Right Thrust Bearing	Eliminates Lateral Play
E	Left Thrust Bearing	Eliminates Lateral Play
F	Follower Gear	144 Teeth (Brass)
G	Driver Gear	10 Teeth (Brass)
H	Friction Clutch Disk	3 inches O.D. (Nylon)
I	Non-Reversible Worm Gear	100 Teeth (Brass)
S_1, S_2, S_3	Pressure Plate Adjustment Screws	Sets Friction Factor

ABOVE: Figure 3 Right Ascension Gear Arrangement

To provide a massive, large bearing surface, the 3-point adjustable, nylon friction clutch on the polar axis is a full 3-inches diameter. As shown in Figure 3, the right ascension gear arrangement is a two shaft drive design. It has the detailed specifications and characteristics indicated in Figure 3.

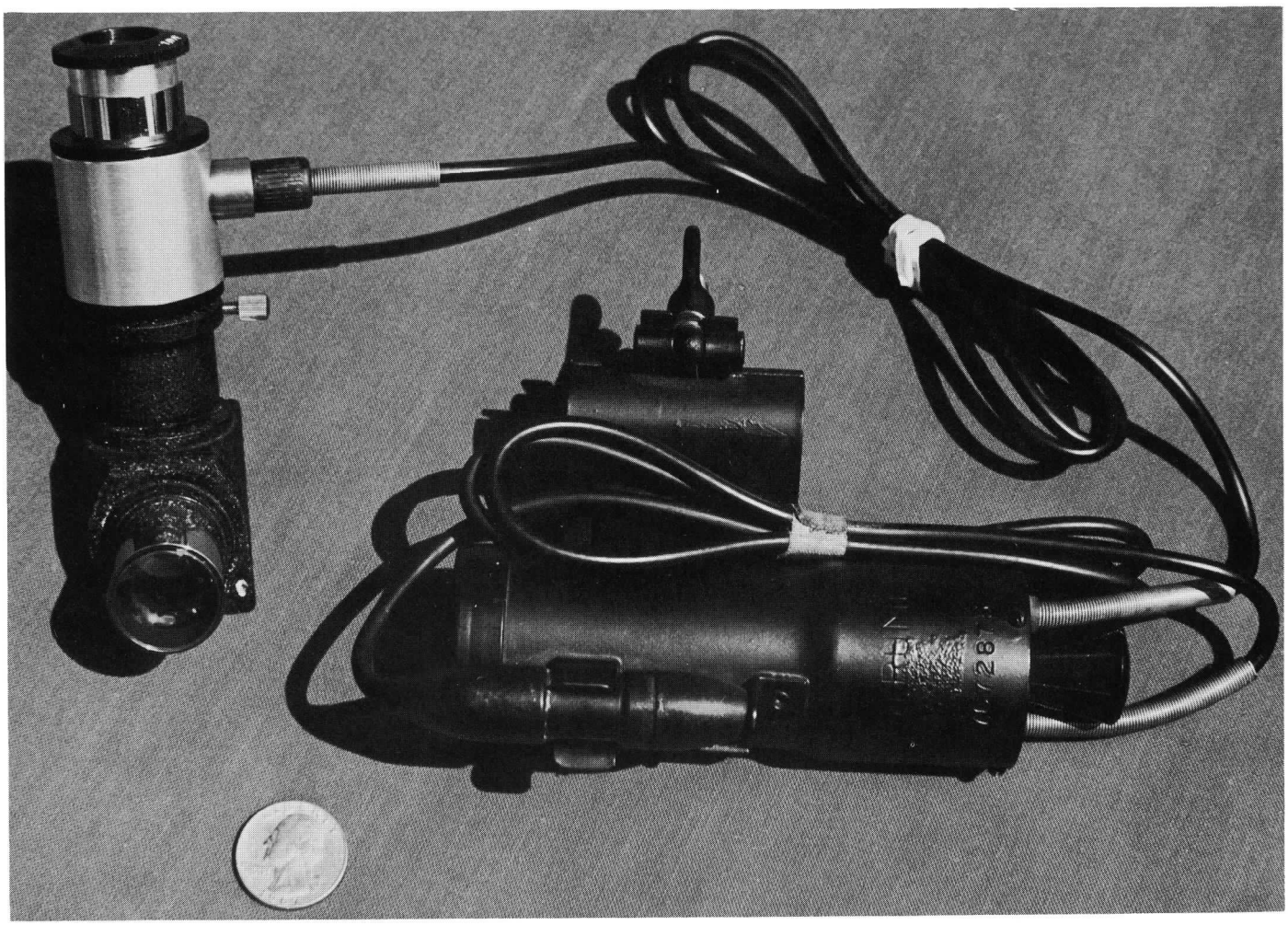
The synchronous right ascension drive utilizes a 4.3 inches diameter main worm gear, which is driven by a polished steel worm. The main worm shaft is coupled to the high torque motor through two precision brass gears, which isolate all thrust forces from the drive motor shaft. The driving rate is correct within 4 seconds per day, and the nylon clutch permits the telescope assembly to be moved manually from one sky object to another, with the motor drive taking over and accurately following once the selected object is in view.

Like the polar axis shaft, the declination shaft has a diameter of 1.5 inches. Each of these shafts is centerless ground to 0.0003 inch tolerance for very smooth operation and Hard chrome plated to prevent rusting. Furthermore, to assure exact 90 degrees alignment of the declination axis with the polar axis, the declination axis housing was precisely machined on a boring mill. This procedure is a must for astrophotography and setting circle work.

A screw-on disk located on the far end of the declination shaft precludes the possibility of smashed toes caused by falling counterweight. Each axis of the mount has a Hurst drive motor of 5 watts power rating. In practice, this wattage limit is never approached due to the smooth, no-play action of the axial ball bearings. Encapsulating metal covers shield the Boston drive gears for each axis from dust and moisture.

To dial in faint objects, 6 inches OD, black anodized aluminum setting circles with white enamel filled calibration lines and numbers are used on each axis in conjunction with vernier pointers. Unlike plastic circles, they will not warp or otherwise distort. By choice, the right ascension circle is a Porter slip ring style, reading directly in the sky.

To avoid a maze of wires, a single 1.5 V Battery powered lighting system clamps to the right side counterweight rod and individually illuminates both the setting circles and the crosshairs of the guiding eyepiece shown in Figure 4. The amount of illumination on the crosshair reticle of the guiding eyepiece is set with an adjustable

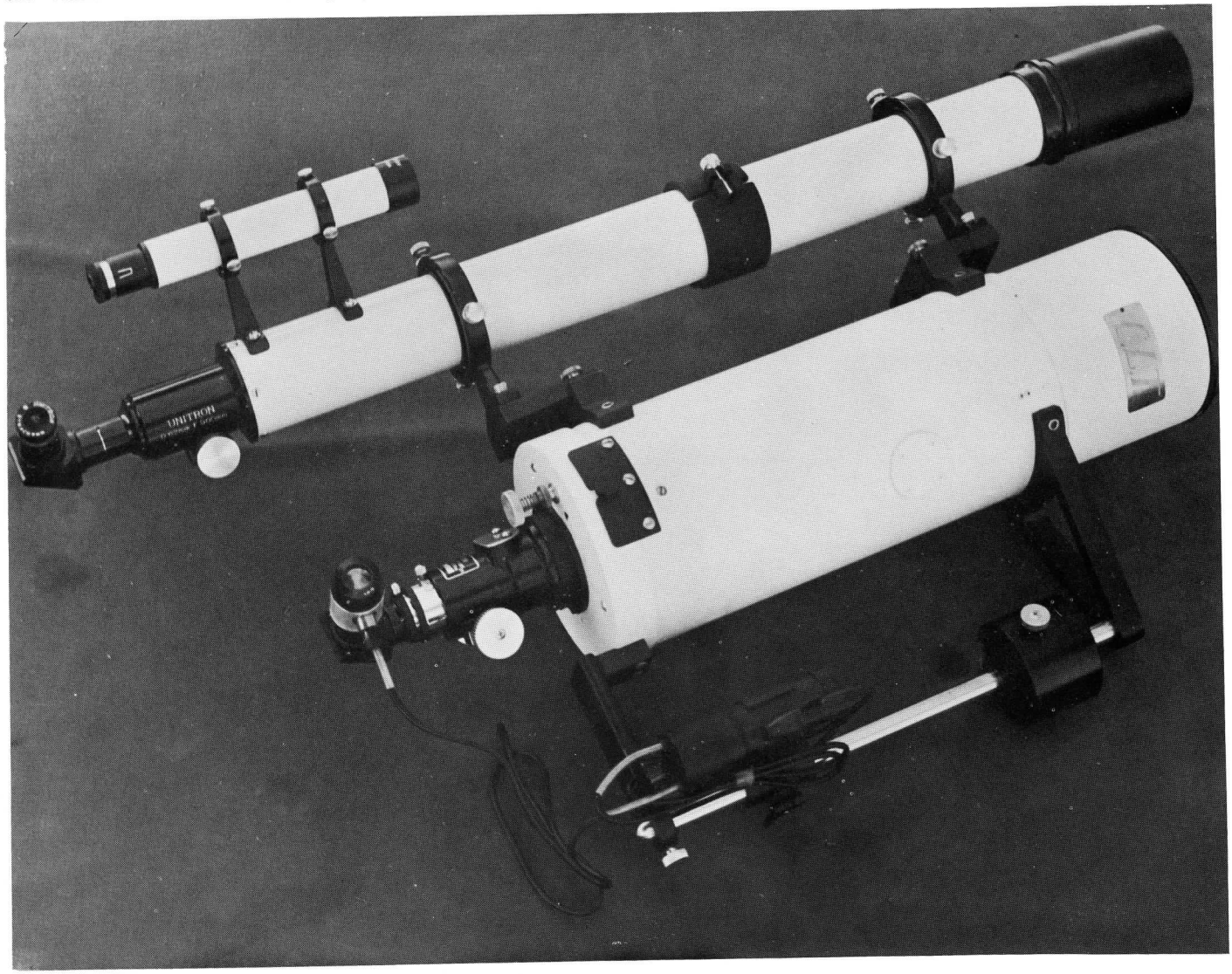


ABOVE: Figure 4 Illuminated Crosshair Guiding Eyepiece

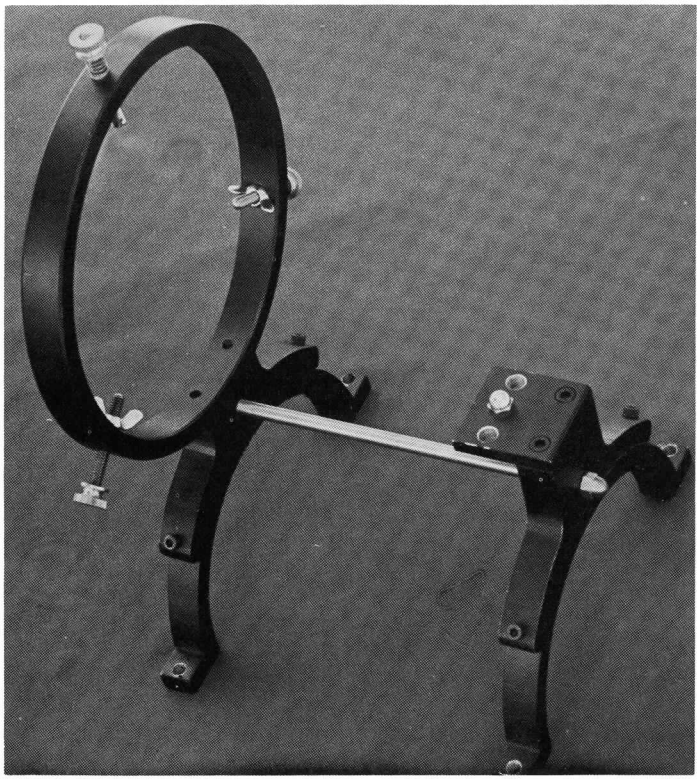
rheostat. The formation of dew on lens surfaces is inhibited by dew cap extensions and by passing current through insulated coils of wire wrapped about the appropriate lenses.

The photo-visual optical assembly quick-mounts with four knurled thumb-nuts in a craddle on top of the equatorial tracking mount. Because of the choice of a pier over a three-legged tripod, the optics assembly never strikes any legs when pointed near the zenith. As shown in Figure 5, the photo-visual optical assembly is comprised of (1) a 2.4 inches aperture, F/15 Unitron guide scope, (2) a modified 5.0 inches clear aperture, F/8 to F/64 Gregory Maksutov telescope, (3) a 4.5 inches clear aperture, F/4.5 Super Takumar telephoto lens, and (4) a 2.0 inches clear aperture, F/2.8 Lentar telephoto lens (not visible). All of these lens systems were carefully chosen to form a complementary battery of all-purpose photo-visual instruments. For example, the tube length, resolution, and light gathering power of the Takumar and modified Gregory Maksutov lens systems are approximately the same, while the effective guiding focal length of either the Unitron or modified Gregory Maksutov telescope can be made roughly 4 to 8 times that of the Takumar lens using either positive or negative lens projection techniques. To obtain a flat, tolerably color corrected, and relatively coma free field at the F/8 focus of the main telescope, a second plano-convex, aspheric corrector is placed immediately in front of the rear-aluminized meniscus corrector of the customary Gregory-Maksutov design. Even so, near the edge of the field of view of the modified Gregory Maksutov telescope F/8 focus, mild coma is detectable. However, this coma is negligible at F/16, and the modified Gregory-Maksutov telescope easily meets both the Rayleigh and Dawes performance criteria at points far off-axis provided the alignment is precise.

Adjustable ring mounts are used to mount and boresight the Unitron guide scope to the body of the modified Gregory-Maksutov main telescope. The Unitron guide scope and ring mounts can be detached as a single unit. A front ring mount and rear swivel mount are employed to mount the Takumar lens (see Figure 6 and the October-Nov. 1973 issue of the ASTROGRAPH). The Lentar lens side-mounts to the craddle using a C-clamp



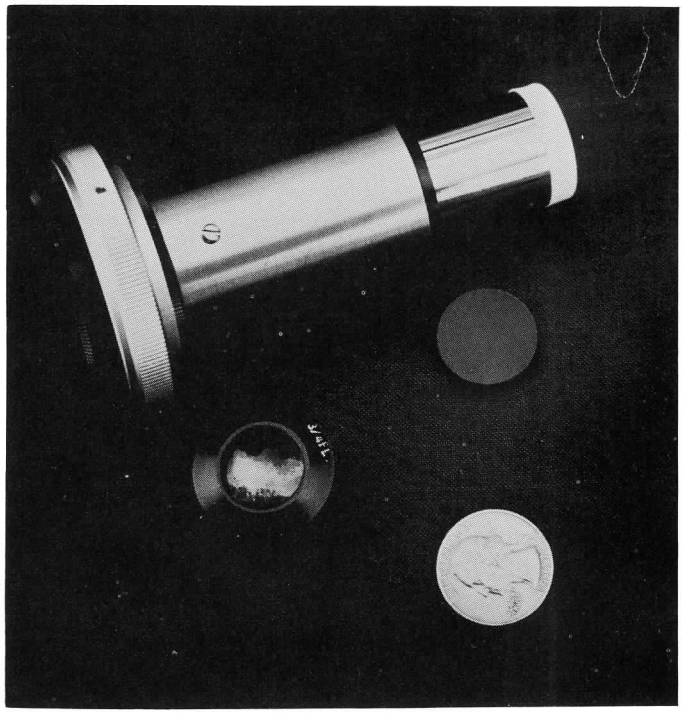
ABOVE: Figure 5 Photo-Visual System Optical Assembly



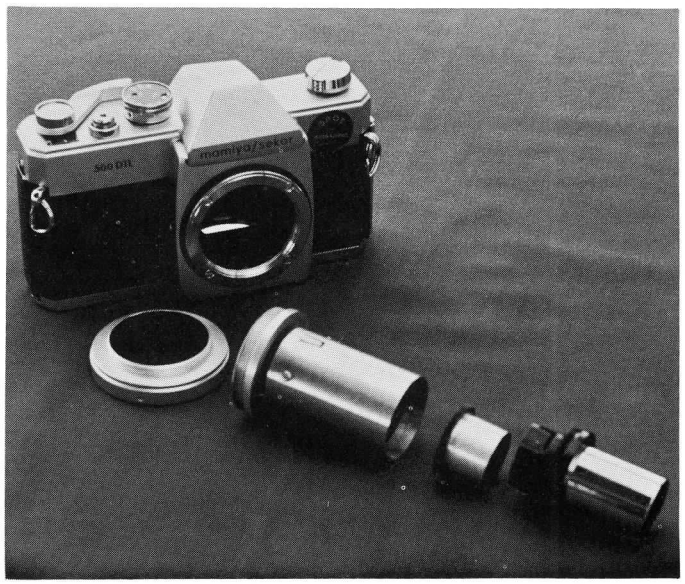
ABOVE: Figure 6 Takumar Lens Mounting Unit

camera bracket. A rigidity bar has recently been added to further stabilize the Takumar lens mounting system (see Figure 6). Also, protruding twin handles have been added to the rear of the craddle to allow easy pointing and manual steering of the optical assembly when locating objects with the 8 x 32 finderscope of Figure 6. For afocal photography, a camera having a between-the-lens shutter is longitudinally positioned and clamped on a support rod that extends from the rear of the craddle. On the other hand, for positive and negative projection photography through the modified Gregory-Maksutov telescope, the eyepiece projection unit shown in Figures 7 and 8 is used. As indicated in Figure 8, various high acuity eyepiece/filter combinations are possible.

To facilitate assembly, prevent damage, and minimize set-up time for the system, the hand-held right ascension and declination control boxes are hangable from the rear of the mount, the sliding counterweights have knurled knobs instead of Allen screws, and the dust and dew caps are of the popoff type. Typical set-up and alignment time for the total photo-visual system is 52 minutes. This short time is possible because two people are involved, and four custom fitted storage and carrying cases such as the one shown in Figure 9 are available. Before the carrying cases were built, set-up and alignment time was 90 minutes, and the danger of leaving or losing small parts at the observing site was great. A small 4'W x 6'L trailer is used for transportation of the photo-visual system and camping equipment to the nearby Southern California mountains where seeing conditions are ideal.



ABOVE: Figure 7 Exterior Appearance of Eyepiece Projection Unit



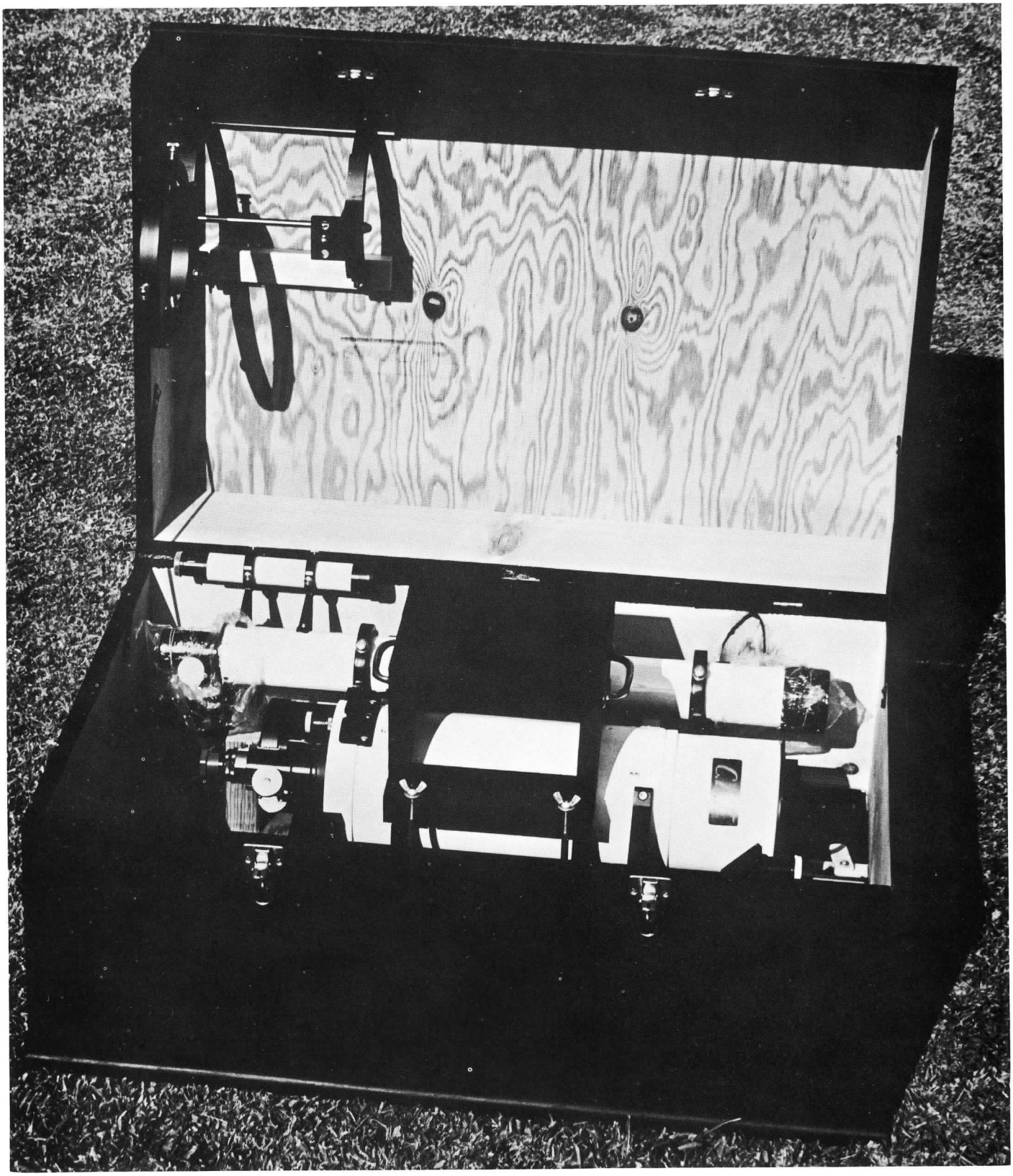
ABOVE: Figure 8 Exploded View of Eyepiece Projection Unit

EQUIPMENT USAGE

Normally, the Unitron telescope serves as a guide scope and seeing monitor for the Maksutov telescope. Similarly, the Maksutov serves as a guide scope and seeing monitor for the Takumar lens and other lens/camera combinations. Single lens reflex, 35mm camera bodies are exclusively used with the photo-visual system. This procedure permits the use of a wide variety of films and enables home processing to be conveniently executed.

For photography of open star clusters, large angular subtense galaxies, and diffuse nebulae, the 20-inches FL, F/4.5 Super Takumar lens of

Figure 1 is used. To obtain lunar close-ups and planetary photographs, the 40 inches FL, modified F/8 Gregory-Maksutov telescope of Figure 5 is used in either an eyepiece projection configuration or an afocal configuration. For star field or comet photography, a side-mounted 135mm FL, F/2.8 Lentar lens is normally used. Other subjects such as globular star clusters and planetary nebulae are not suitable subjects because of image scale considerations. Guiding is accomplished using the electrical slow motion controls depicted in Figure 1 and either the 2.4 inches aperture, F/15 Unitron refractor, or the 5.0



ABOVE: Figure 9 Optics Assembly Storage and Carrying Case

inces effective aperture, F/8 Gregory-Maksutov telescope. In either case, the illuminated 8X guiding ratio crosshair eyepiece of Figure 5 facilitates guiding. Visual observations are customarily made using the Gregory-Maksutov telescope.

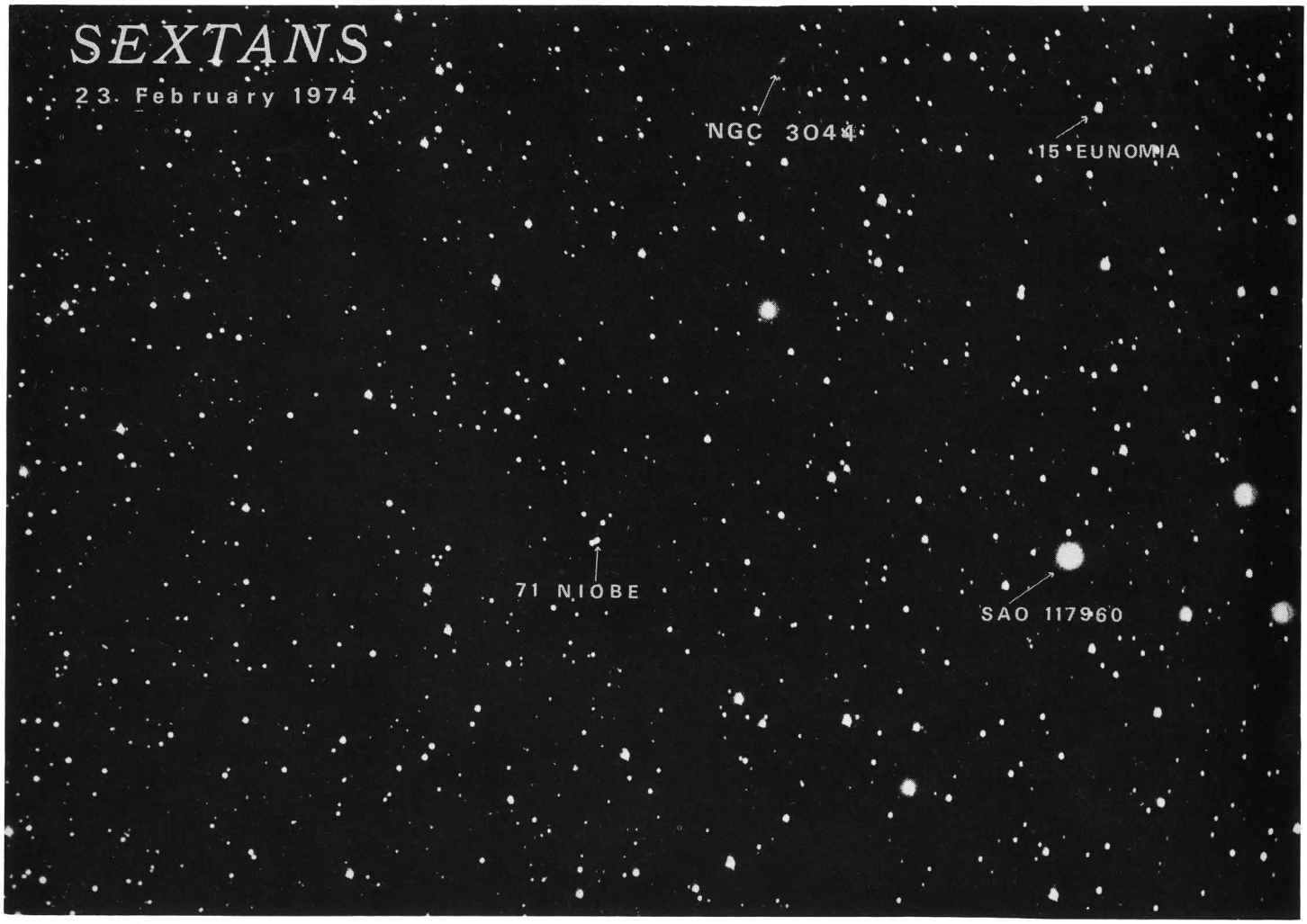
PERFORMANCE RESULTS

Overall photo-visual performance of the system shown in Figure 1 has been excellent. To date, most of our astronomical photography has been conducted with black and white films, but we are presently in the process of acquiring color slides of some of the lesser known astronomical subjects.

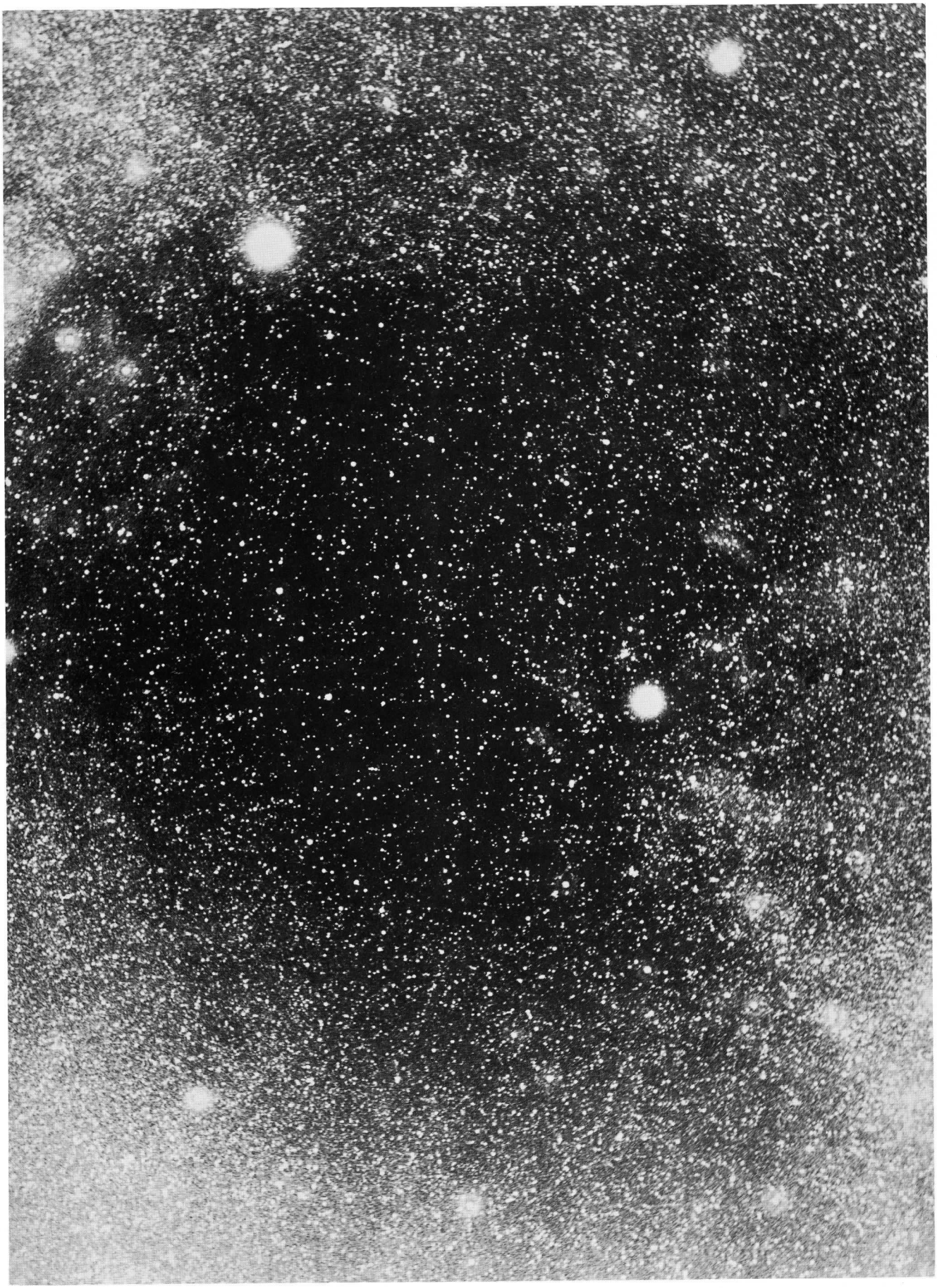
One of the design features of our system that could stand improvement is the electrically-driven declination drive. Since its drive motor operates only at a speed of 1/3 rpm, a second slower speed would be advantageous for fine guiding corrections. For acquisition, the higher speed is entirely satisfactory. On the other hand, since the declination control circuit and the right ascension control circuit for our system are contained in separate hand-held housings, a manual declination control might have served as well as the electric declination control, and it would have cost less.

Test photographs taken with the system are shown in Figures 10 and 11. The photograph of Figure 10 shows asteroids 15 Eunomia and 71 Niobe as captured on Kodak 103a-F film in a 30 minute guided exposure through the Takumar lens. Figure 11 shows a dark circular rift near Gamma Cygni as captured on 103a-F film in a 15 minute guided exposure through the Lentar lens. For the circular rift photograph, the 103a-F film was processed in D-19 for 4 minutes at 68°F. However, for the 15 Eunomia and 71 Niobe photograph, the 103a-F film was processed in MWP-2 for 9 minutes at 70°F.

Using 35mm Kodak Plus-X and Tri-X films in combination with special processing techniques and the modified Gregory-Maksutov telescope, we have been able to obtain lunar close-up shots that are of a quality comparable to those obtained by Howard Zeh and featured in the January/February 1973 issue of Modern Astronomy However, it is a sad fact that an instrument of eight-inches aperture has better resolution and increased light gathering power relative to one of five inches aperture, and an experienced observer can easily detect the difference when



ABOVE: Figure 10 Asteroids 15 Eunomia and 71 Niobe



ABOVE: Figure 11 Dark Circular Rift Near Gamma Cygni

examining photographs taken with each instrument.

Our most photogenically pleasing shots have been made using GAF 500 color slide film and the 20 inches FL, F/4.5 Super Takumar lens to capture the brighter diffuse nebulae. However, our intent is to use the Takumar lens primarily for the photographic study of asteroids, variable stars, and the detection of intra-galactic novae. Using 103a-F film and 30 minute exposures, one can penetrate to magnitude 15 with the Takumar lens provided dark sky and good weather conditions prevail. In comparison, the Lentar lens penetrates to magnitude 12 under the same circumstances. The diagonal field of view of the Lentar lens is 18° whereas the diagonal field of view of the Takumar lens is 5°. Both lenses are fine performers. We accepted them on a trial basis by putting down a 10% deposit fee, and only bought them after bench and field tests demonstrated their degree of perfection.

SUMMARY

Tests have shown the photo-visual patrol system to be ideal for its intended applications. Its equatorial head is sufficiently massive to rapidly damp out wind and hand vibrations, and its drive is precise enough to smoothly counteract diurnal motion. Because the main tube is short and of the proper weight to complement the equatorial head, there are no vibrations that are visually unpleasant or photographically ruinous. Its design features are recommended for use in or incorporation into the photo-visual systems of other observers.

Charles and Margaret Townsend
(Ventura County Astronomical Society)

ASTROPHOTOGRAPHY FOR JUNE AND JULY

MERCURY is in good photographic position on June 4 when it reaches a Greatest Eastern elongation of 24° and has an apparent declination of $+25^{\circ}$. On June 31 it reaches inferior conjunction and Greatest Western elongation of 20° on July 22 when it will be at R.A. $6^{h}\ 38^{m}$, Declination $+21^{\circ}$. Mercury reaches superior conjunction on August 17th.

VENUS reached Greatest Western elongation on April 4 and is moving to superior conjunction which it will reach on November 7.

The MOON reaches its highest declination on June 19 11^{h}, July 16th 22^{h}, and August 13th 8^{h}. It reaches perigee one June 21st 14^{h}, July 19th 22^{h} and August 17th 07^{h}.

As can be seen in the table, the cresent phases are in good photographic position and especially the last quarter and cresent phases in July and August. August, September and October will be excellent months for photographing the last quarter phases.

Lunar phases are as follows:

PHASE	DATE	DECL.	DIAMETER
Full	June 4 (22 hr.)	-23°	30'04"
Last Quarter	June 13 (02 hr.)	$+10^{\circ}$	30'02"
New	June 20 (05 hr.)	$+23^{\circ}$	33'00"
First Quarter	June 26 (19 hr.)	-6°	31'38"
Full	July 4 (13 hr.)	-21°	29'35"
Last Quarter	July 12 (15 hr.)	$+12^{\circ}$	30'32"
New	July 19 (12 hr.)	$+18^{\circ}$	33'25"
First Quarter	July 26 (04 hr.)	-16°	31'14"
Full	Aug. 3 (04 hr.)	-14°	29'24"
Last Quarter	Aug. 11 (03 hr.)	$+20^{\circ}$	31'09"
New	Aug. 17 (19 hr.)	$+9^{\circ}$	33'22"
First Quarter	Aug. 24 (16 hr.)	-22°	30'37"
Full	Sept. 1 (19 hr.)	-4°	29'38"

EARTH reaches Summer solstices on June 22.

MARS is unfavorably placed for photography in Cancer. It reaches conjunction on October 15th.

JUPITER is in Aquarius and is relatively unfavorably placed for photography at Declination -6°. On July 1st, Jupiter is positioned at R.A. $23^{h}17^{m}$ Declination -5° 56' and on August 1st at R.A. $23^{h}14^{m}$ Declination -6° 25'. Jupiter's diameter increases from 40.5 arc seconds on June 1 to 44.2 arc seconds on August 1. Jupiter is stationary in R.A. on July 8 and reaches opposition on September 6.

URANUS is stationary in Virgo on July 2nd when this sixth magnitude 4 arc second diameter planet is located at R.A. $13^{h}28^{m}$ Declination -8° 39'. On August 1 it is located at R.A. 13^{h} 30' Declination -8° 49'.

NEPTUNE moves into Scorpius in July. This 8th magnitude 2.5 arc second diameter planet is located at R.A. $16^{h}24^{m}$ Declination $-19^{\circ}57'$ on July 1 and R.A. $16^{h}22^{m}$ Declination $-19^{\circ}53'$ on August 1.

PLUTO is a 14th magnitude planet in Virgo and is well placed for photography after sunset. On July 4 Pluto is located at R.A. $12^{h}41^{m}$ Declination $+13^{\circ}42'$, and on August 1 it is located at R.A. $12^{h}42^{m}$ Declination $+13^{\circ}19'$. Pluto was actually in Coma Berenices during April, May and June moving into Virgo in July.

EVENTS

The Sun will be totally eclipsed on June 20th for an area of the Indian Ocean, Australia and Antarctica.

The Moon will be particially eclipsed on June 4 for areas of Australia, Asia, Africa, Europe, South America, and Antarctica.

Venus is occulted by the Moon on July 17 11^{h} for areas of Central America, East of North America, South Greenland, North Atlantic, Europe, North of North Africa, and Southwest Asia.

Pallas Reaches opposition on July 24 17^h.

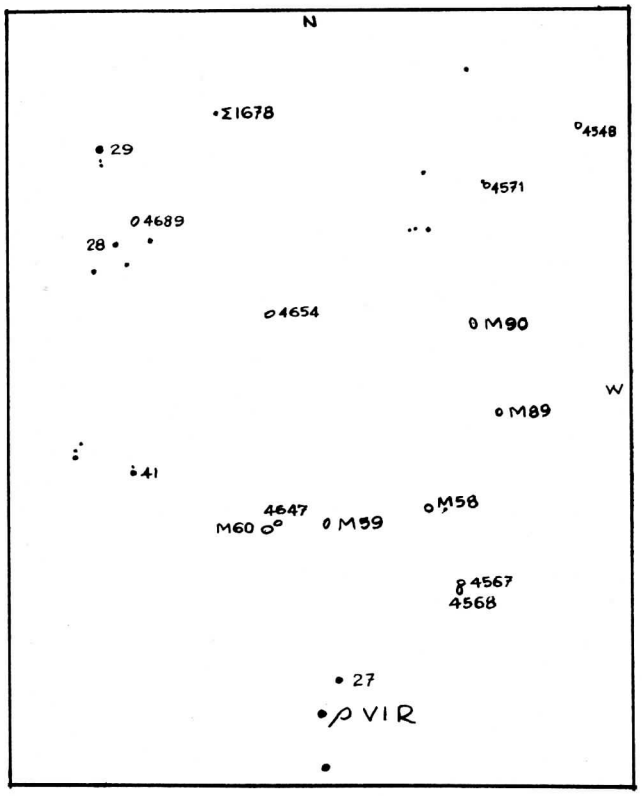
MINOR PLANETS

Planet	Magnitude	Position July 1 R.A.	Decl.	August 1 R.A.	Decl.
Ceres	7.8-7.5	23^h23^m	-16°58'	23^h23^m	-19°33'
Pallas	9.3	19^h58^m	+20°10'	19^h34^m	+17°53'
Juno	9.1-8.6	23^h01^m	+1°28'	23^h07^m	+0°57'
Vesta	6.6-6.9	12^h51^m	+2°38'	13^h29^m	-3°09'

COMET BRADFIELD (1974b) POSITIONS

Date	R.A.	Decl.	Mag.
June 2	$14^h\ 25^m$	+78° 35'	12.0
June 7	$14^h\ 31^m$	+75° 44'	12.3
June 12	$14^h\ 35^m$	+72° 58'	12.7
June 17	$14^h\ 40^m$	+70° 16'	12.9
June 22	$14^h\ 44^m$	+67° 38'	13.2
June 27	$14^h\ 49^m$	+65° 04'	13.5

RALPH PROCTOR



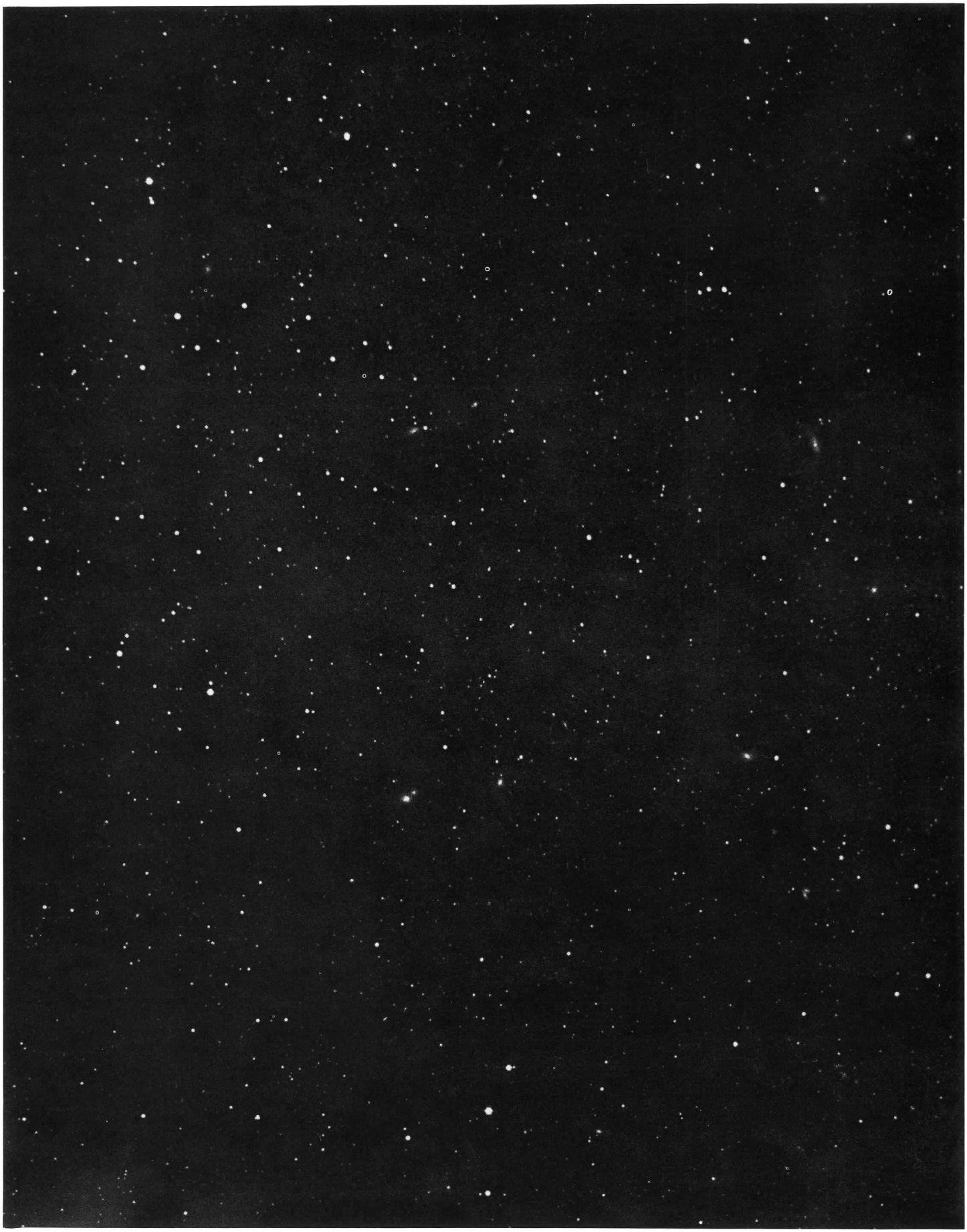
ABOVE: One half scale key of photograph on page 93.

VIRGO

Virgo is the sixth constellation of the zodiac, and the second largest in area of all the constellations. Although there are many good double stars in Virgo, the group's chief glory lies in the area called the "Realm of the Nebulae", or more accurately, "Realm of the Galaxies", now that we know the objects observed in the area are separate systems of stars, gas, clusters, and nebulae. The Virgo cluster of galaxies has about 13, 500 objects brighter than magnitude 15.5 and spreads out through northwestern Virgo, and into Coma Bernices, leo, and Corvus. The center of the cluster is generally accepted as being at R.A. $12^h\ 27^m$ and decl. +12°36'.

Photographically, the galaxies of Virgo present similar problems to those of Leo discussed in the February-March issue. However, the Virgo cluster is further away than the brighter Leo galaxies, so the majority of objects appear to be somewhat smaller and fainter. A 50mm lens and fairly fine grain film such as Plus-X Pan will show the existance of many of the galaxies, in a 15 minute exposure at F/4 or faster (F/2.8 is better). However, a great deal of enlargement is necessary to distinguish the objects from stars. A top quality enlarging lens is very necessary here, when going bigger than 8 x 10, the enlarger optics really are important. Several high quality enlarging lenses have come on the market recently, joining the two best 50mm lenses, the Schneider Componon and El-Nikkor, are the Fujinon-E and the Komura Enlarging lens. A print size of at least 11 x 14 is necessary for identification of the small objects. A 105mm lens will allow easier identification on an 8 x 10 print, and also afford a larger aperture to start with, increasing space penetration. Another thing noted when making the observations for this article: the faster F/ ratio photographs show the galaxies as being much larger than those taken at F/4 or slower. The reason being that the fast lens photos (specifically those with the 105 Nikkor at F/3 and the Schmidt at F/1.65) show the fainter outer regions of the galaxies (arms in spirals, etc.) while the slower photos (55mm Nikkor at F/4, 300mm at F/6.3) only show the brighter nucleus areas, therefore the apparent size **difference with fast or slow F ratios.**

Another difference which might make some decide which film to choose was this comparison: I shot the area with 105mm Nikkor at F/3 and used 15 minute exposures. Two films were compared, 103aF and Plus-X. The 103 was developed in D-76 (less grain than D-19) and the Plus-X developed in a mixture that I standardized on for regular photography, Ethol Blue. The 103 negative showed somewhat fainter objects, with the outer areas of the galaxies burned out or overexposed, and was quite grainy. The Plus-X did not show the faint areas as well, but actually did show the arms of some galaxies, due to its sharpness



ABOVE: Eastern part of the center of Virgo cluster on March 12, 1972 by John Sanford, at the site of the Orange County Astronomers with a 5.5 inch F/1.65 Schmidt camera. This ten minute exposure was on 103aF film developed in D-76. See Key on Page 92.

and lack of objectionable grain. With a few more minutes exposure, the Plus-X would have resulted in a negative superior in quality than the 103, although still not going quite as faint as the 103. I think Plus-X in Ethol Blue or the new H&W developer Maximal, is a superior film for most short focal length deep sky work, as it has better graininess, resolution, and allows small objects to be seen and identified much better than either Tri-X or 103.

Within Virgo there are a number of pretty and interesting double stars which were examined by the writer. Of course the most interesting or at least most observed is Gamma, one of the finest binaries in the entire sky. The separation was first measured by Cassini in 1720, and varies from 0.25 seconds (1836) to 6.0 seconds (1922). The distance is now closing but will remain wide enough for easy observation for some years (p=171 years). On 1973.0 the separation was 4.4 seconds. The stars are both 3.5 magnitude, adding up to a 2.8 naked eye star, which makes it a little more difficult than might be expected to photograph the components. It takes good seeing, eyepiece projection and a few seconds exposure to record this double star. This is probably the only double in Virgo that the amateur would have an easy time capturing. Pictures taken several years apart of Gamma should show both orbital motion and separation change, if the optical system used is the same on both exposures so there is no possibility of scale change, and the pictures are carefully compared.

Probably the best galaxy for long focus photography in Virgo is the Sombrero Galaxy, M 104, (NGC 4594), lying on the border of Corvus. It has several interesting features. First, it is easy to locate and has a stellar nucleus, has a prominent dust lane almost through the middle and is relatively large and bright. The lane can be seen in an 8" in good sky. With long focus rather slow F/ratios (such as F/6 and slower), the 103 or Tri-X in a cold camera would be the best choices of film. The advanced amateur might try to see a difference in galaxy photographs taken with the predominantly blue sensitive 103a-0 and the 103a-F (with yellow filter) to see if the redder Population II nuclear stars show up better on the yellow photograph as they should.

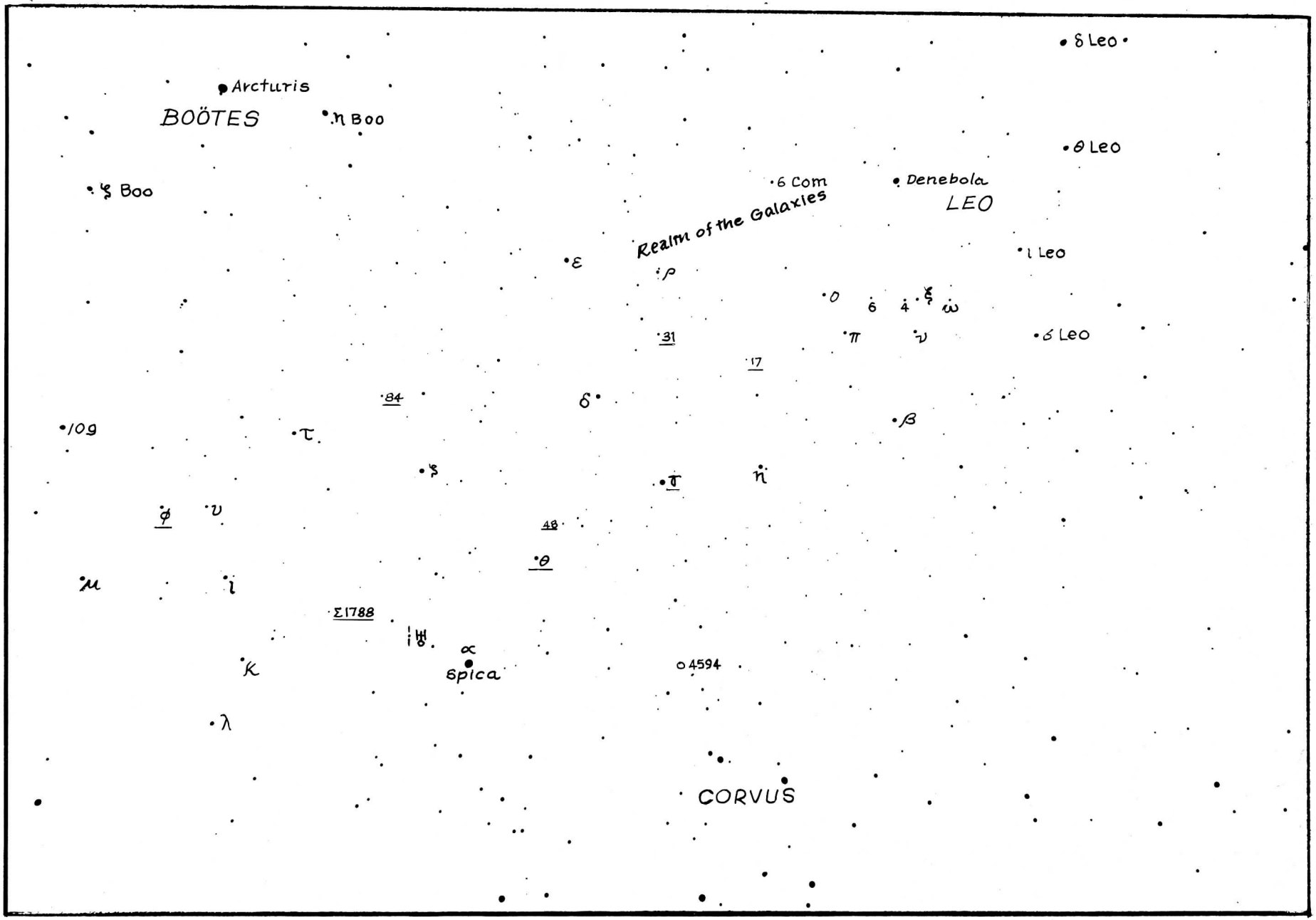
GALAXIES IN VIRGO

NGC	R.A.	DECL.	SIZE	MAG.$_v$	TYPE	REMARKS
4303	$12^h19.4^m$	+04°45'	5'.6x5'.3	10.1	Sc	M 61 round, fair brt.
4374	$12^h22.6^m$	+13°10'	1'.6x1'.4	9.3	E1	M 84 sml, brt. nuc.
4406	$12^h23.7^m$	+13°13'	2'.1x1'.4	9.7	E3	M86 in fld M 84
4472	$12^h27.3^m$	+08°16'	2'.8x1'.8	8.6	E4	M49 12m star Est.
4486	$12^h28.3^m$	+12°40'	1'.9x1'.8	9.2	E1	M87 4478 in fld.
4552	$12^h33.1^m$	+12°50'	1'.3x1'.3	9.5	E0	M89 13m star Est.
4567-8	$12^h34.0^m$	+11°32'	2'.4x1'.6	-	Sc	2 gal. touching
4569	$12^h34.3^m$	+13°26'	7'.5x2'.2	10.0	Sc	M90 lge. dim
4579	$12^h35.1^m$	+12°05'	4'.4x3'.5	9.2	SB	M58 sm. dim
4594	$12^h37.3^m$	-11°21'	6'.0x2'.5	8.7	Sb	M104 lane, nuc, 8"
4621	$12^h39.5^m$	+11°55'	2'.7x1'.6	9.6	E3	M59 small dull
4649	$12^h41.1^m$	+11°49'	2'.0x1'.8	8.9	E1	M60 with 4647nw

MULTIPLE STARS IN VIRGO

*	R.A.	DECL.	SEP.	PA	MAGS	REMARKS
17 Vir	$12^h20.0^m$	+05°35'	20"	337	6.5-9.0	yellow&white unequal
Gamma	$12^h39.1^m$	-01°11'	4.4"	308	3.5-3.5	both white exceptional
31	$12^h39.4^m$	+07°05'	4.0"	36	5.5-11.6	comp not seen, 8" 250x?
48	$13^h01.3^m$	-03°24'	0.8	206	7.2-7.3	good test, split 500x 8"
Theta	$13^h07.4^m$	-05°16'	7.2	341	3.4-9.2	easy pair
84	$13^h40.6^m$	+03°47'	3.2	228	5.6-8.2	faint pr. Sf,11.612.8,2"
Struve 1788	$13^h52.3^m$	-07°49'	3.4	91	6.5-7.7	good obj. sml. apert.
Phi	$14^h25.6^m$	-02°00'	4.5	110	5.0-9.7	unequal, both orange

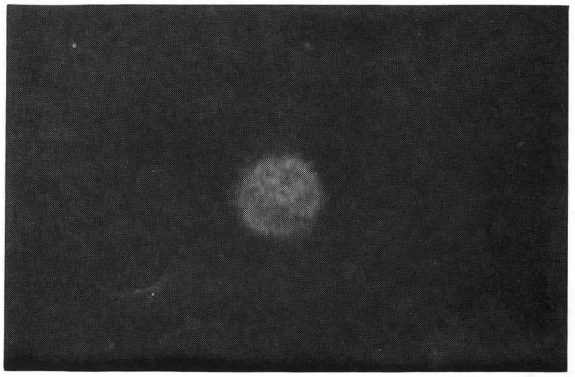
JOHN SANFORD



ABOVE: Constellation VIRGO by John Sanford.



ABOVE: Comet Bradfield photographed by M.R. O'neal on April 12, 1974 at 5:00 p.m. PDT on Saddle Peak, Malibu, California. This 30 minute exposure was taken at the prime focus of a 6 inch F/8 reflector on 103aF film developed for 9 minutes in MWP-2. Enlargement is 5X on BROVIRA #5 paper.



ABOVE: Disk of the planet Uranus photographed by Jim Hofman on April 24, 1974 using a 6 inch refractor at the University of Notre Dame Observatory. Exposure was 6 seconds. Negative enlargement was 5X.



ABOVE: Comet Kohoutek photographed by Douglas C. Huston on January 13, 1974 using a Pentax 35mm SLR, 135mm F/2.8 Tamron lens and Vivitar 3X tele-converter. Exposure was 2 minutes on Panatomic-X film.



ABOVE: Moonscape photographed by E. Ken Owen on May 28, 1969. This two second exposure was on Plus-X film with a ten inch F/6.150 Newtonian working at F/80. Seeing was rated at 2(0-5) and a 35mm Miranda "G" camera was used.