nightwatch

Newsletter of the Pomona Valley Amateur Astronomers

When it is dark enough, men see the stars.
Ralph Waldo Emmerson

We are in Shanahan B460
May 17, 7:30pm.

Volume 39 Number5 ***nightwatch*** **May 2019**

President's Message

Our May meeting will feature a double header as we have two speakers presenting to the Club this month. Our presentations on Friday, May 17th at 7:30pm will be given by Luisa Rebull and Ken Elchert.

First will be member Ken Elchert who will take us back 50 years to the launch of Apollo 10 in 1969.

The other speaker is Luisa Rebull, Research Scientist, Infrared Science Archive (IRSA), Caltech/IPAC. The title of her presentation is: "Getting Your Hands on Real Astronomy Data".

Did you have a cloudy night but still want to do some astronomy? Do you really want to see the sky tonight but you also like running water and A/C? There is a ton of research-quality astronomy data available to you *right now*. You just need to know how to get access to it! In order to understand how astronomical images work, you need to know about what color images really are, so I'll spend time on that. I'll cover a few of the many ways that you can get access to real data, from citizen science web-based projects to FITS files. I'll cover a few basics of how to interpret astronomy images, some of which you may already know from your own telescope imaging projects.

I hope you will be able to join us for some great astronomy topics!

Matt Wedel

Club Events Calendar

May 17 General Meeting - Apollo 10 by Ken Elchert and "Getting Your Hands on Real Astronomy Data" Lisa Rebull
May 18-19 JPL Open House

Jun 1 Star Party – White Mountain
Jun 5 Board Meeting
Jun 14 General Meeting Apollo 11 Ken Elchert

Jul 10 Board Meeting
Jul 19 General Meeting
Jul 27 Star Party – Table Mountain

Aug 3 Nature at Night GS Camp - Nawakwa
Aug 7 Board Meeting
Aug 16 General Meeting
Aug 31 Star Party – TBD

Sept 4 Board Meeting
Sept 13 General Meeting
Sept 19-22 RTMC
Sept 28 Star Party – TBD

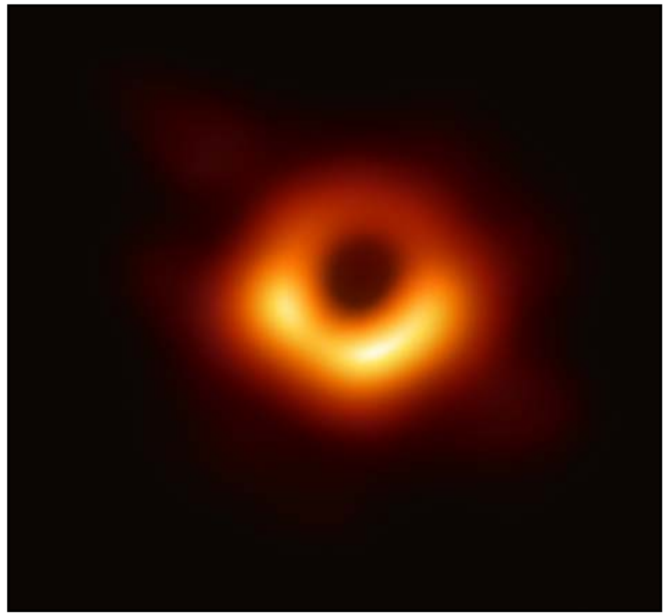
Oct 2 Board Meeting
Oct 11 General Meeting
Oct 26 Star Party – TBD

Nov 6 Board Meeting
Nov 15 General Meeting Apollo 12
Nov 23 Star Party – TBD

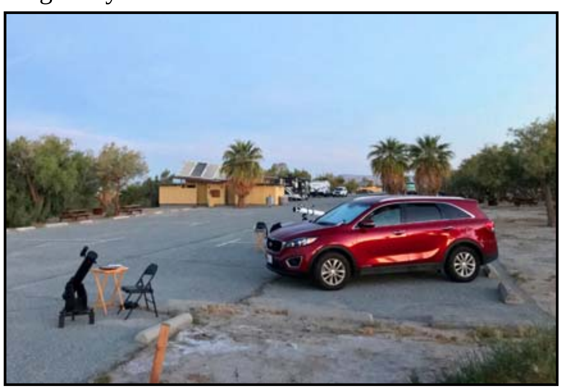
General Meeting 04/19/19

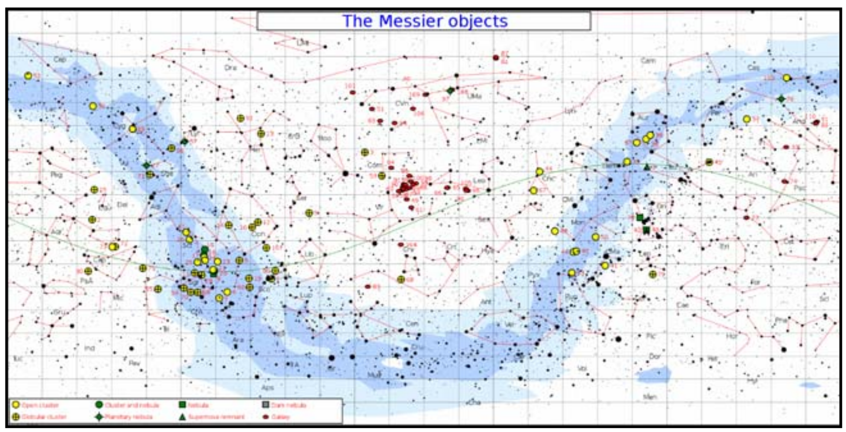
Mathew Wedel opened the meeting and reminded everyone that club dues are due next month. Dues are $30/person or $40/ family. We have a Student Special for those under 18 for $12. We also will be voting on the officers of the club.

Ken Elchert gave a presentation on the just released image of a black hole. The black hole imaged is in M87. Ken stated that the image is of the shadow of the black hole. It was not "observed" in visual light but at a wave length of 1.3mm or a frequency of 230.61 GHz radio band. The EHT (Event Horizon Telescope) is actually a collection of telescopes around the world including one in Antarctica. This was needed to be able to image something smaller than 50 microarcseconds wide. A microacrsecond is one millionth of an arcsecond, which is 1/60th of an arcminute. An arcsecond is 1/3600th of a degree. The black hole is small only because it is so far away – about 54.8 million light years (+/- 2.6 million). To give you an example of how small 50 microarcseconds is, it is the angular diameter of a dime 45,909.4 miles away! The mass of the M87 black hole is 6.5 billion times that of our sun, so it is huge, but just far away. The accretion disk around the black hole is 1,340 AU wide. AU= the distance from the center of the Earth to the center of the Sun, about 8 light minutes, or ~93 million miles. So 1,340 AU is over 7.5 light days across.



M87 Black Hole
California Institute of Technology



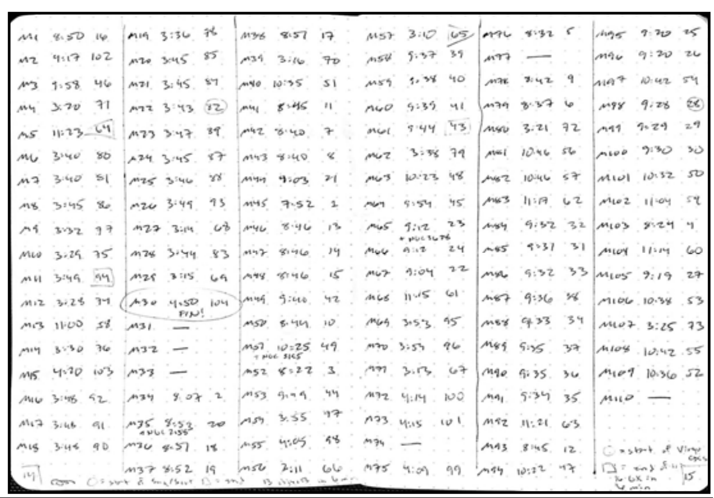


Sky chart with Messier object. - Wikipedia
https://en.wikipedia.org/wiki/Messier_object#/media/File:MessierStarChart.svg

Mathew Wedel also gave a presentation on his Messier Marathon at Mecca Beach at the Salton Sea, the night of April 6th – April 7th. Charles Messier, along with his best friend and assistant Pierre Méchain, created a list of 103 Deep-Sky Objects (DSOs) that were "not comets." As he was a comet hunter, these fuzzy objects looked like comets, but did not move. Later astronomers added 7 more DSOs to the list for a total of 110 DSOs. Ironically, Messier is much better known for the 110 nuisance objects list than for the 13 comets he discovered.

Clouds and the glow from Palm Springs prevented the observations of soon to set M31, M33 & M74. Matt also missed M32, M94, M97 & M110. – For a total of 104 observed for the night! His best has been 108 which he did the night of March 9-10, 2013 and on March 25-26, 2016.

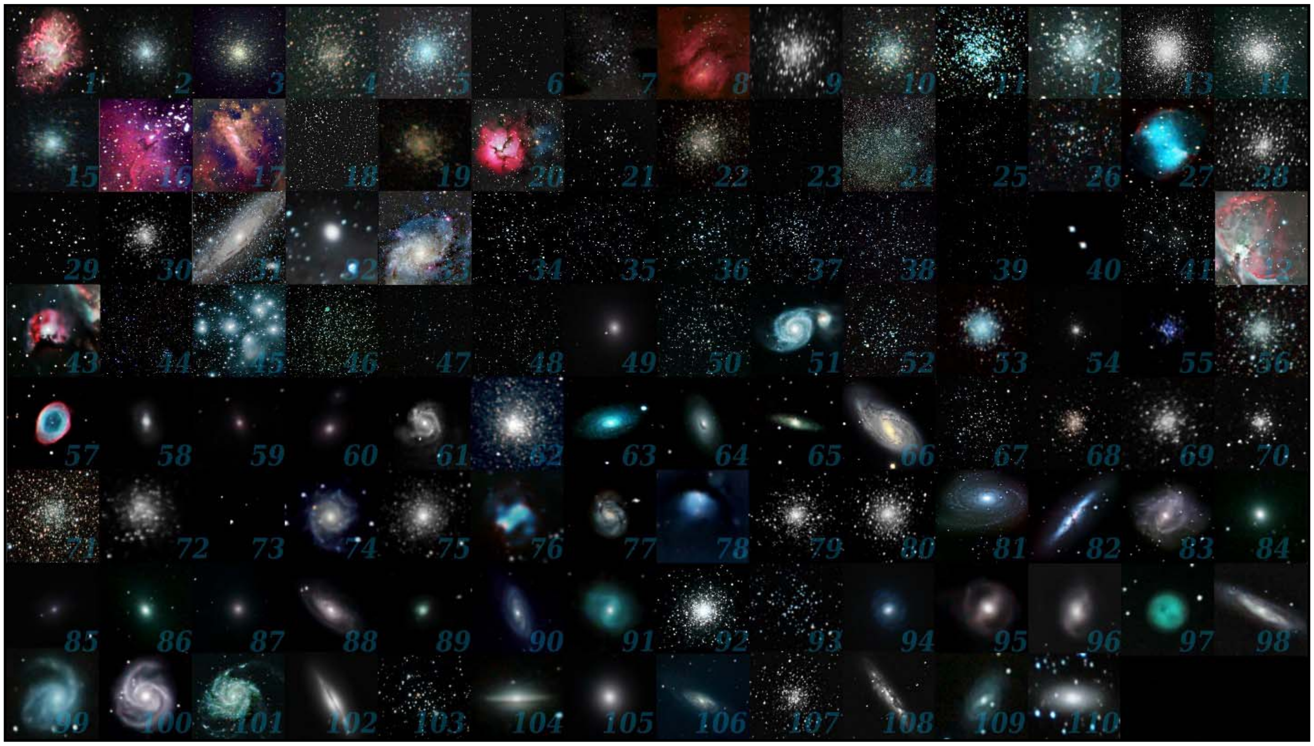
The main presentation was by Gary Thompson. He showed



M1	8:50	16	M19	3:36	78	M38	8:57	17	M57	3:10	65	M76	8:32	5	M95	9:20	25
M2	4:17	102	M20	3:45	85	M39	3:16	70	M58	9:37	39	M77	—		M96	9:20	26
M3	4:58	46	M21	3:45	84	M40	10:35	51	M59	9:38	40	M78	8:42	9	M97	10:42	54
M4	3:20	71	M22	3:43	82	M41	8:46	11	M60	9:39	41	M79	8:37	6	M98	9:28	28
M5	11:23	64	M23	3:47	89	M42	8:40	7	M61	9:44	43	M80	3:21	72	M99	9:29	29
M6	3:40	80	M24	3:45	87	M43	8:40	8	M62	3:58	79	M81	10:46	56	M100	9:30	30
M7	3:40	81	M25	3:46	88	M44	9:03	21	M63	10:23	48	M82	10:46	57	M101	10:32	50
M8	3:45	86	M26	3:49	93	M45	7:52	1	M64	9:54	45	M83	11:19	62	M102	11:04	59
M9	3:32	97	M27	3:14	68	M46	8:46	13	M65	9:12	23	M84	9:32	32	M103	8:24	4
M10	3:29	75	M28	3:44	83	M47	8:46	14	M66	9:12	24	M85	9:37	31	M104	11:14	60
M11	3:49	84	M29	3:15	69	M48	8:46	15	M67	9:04	22	M86	9:32	33	M105	9:19	27
M12	3:23	74	M30	4:50 FIN!	104	M49	9:40	42	M68	11:45	61	M87	9:36	38	M106	10:38	53
M13	11:00	58	M31	—		M50	8:44	10	M69	3:53	95	M88	9:33	34	M107	3:25	73
M14	3:30	76	M32	—		M51	10:25	49	M70	3:53	96	M89	9:35	37	M108	10:42	55
M15	4:20	103	M33	—		M52	8:22	3	M71	3:13	67	M90	9:35	36	M109	10:36	52
M16	3:48	92	M34	8:07	2	M53	9:49	44	M72	4:14	100	M91	9:34	35	M110	—	
M17	3:46	91	M35	8:53	20	M54	3:55	47	M73	4:15	101	M92	11:21	63			
M18	3:48	90	M36	8:57	18	M55	4:05	48	M74	—		M93	8:45	12			
			M37	8:52	19	M56	7:11	66	M75	4:09	99	M94	10:22	47			

Log of observations for the night.

General Meeting 04/19/19 continued



Michael A. Phillips
http://i.imgur.com/NpSgnVi.jpg

YouTube videos. One was from the "Veritasium" channel on the M87 imaged black hole
https://www.youtube.com/watch?v=S_GVbuddri8
In the video Derek Muller gave an easy to understand description of what was imaged and how small 50 microarcseconds is. He also shows the locations of the observatories used on the Earth's globe to get the image.

Another YouTube shown was from a channel known as "Vintage Space" by Amy Shira Teitel. The first of 3 videos from her channel was titled "The Lost Apollo 2 and Apollo 3" and explained why we had Apollo 1 and Apollo 4, but no 2 & 3. https://www.youtube.com/watch?v=C7ULrq9Z9yg 5:10
(5 minutes 10 sec.)

The second of her videos, titled "What did NASA Change after the Apollo 13 Disaster?" detailed the changes made due to Apollo 13's near disaster.
https://www.youtube.com/watch?v=Ehw60sLgBzM 5:12

The 3rd video from the Vintage Space channel was titled "Apollo's Flammable Oxygen Atmosphere Explained"
https://www.youtube.com/watch?v=FvA7N_j_8os 9:13.
This video goes into the decision making behind why Apollo had a pure oxygen atmosphere.

Another video was shown from Apollo 15 where, while standing on the moon, Commander David Scott holds up a hammer and a falcon feather. He drops them and they hit the lunar surface at the same time - proving scientist Galileo Galilei, who lived from 02/15/1564 to 01/08/1642, correct.
https://www.youtube.com/watch?v=oYEgdZ3iEKA 1:22

Amy Shira Teitel of "Vintage Space"
(Picture from YouTube presentation)

How I Got a Job At JPL

I've been using the 11" refractor regularly for public observing from 1977 to now, a span of 42 years. For the first decade after I built it, I took it (on its 800 pound equatorial mount) to sites like Palomar Mountain Observatory, Joshua Tree, the MSAC Planetarium, and of course, several RTMC conventions.

In 1985, I built the present car top mount in preparation for Halley's Comet. I was anticipating major public interest and publicity about the comet, so I wanted the telescope to be far more portable and easier to set-up. Over the next year and a half, I showed Halley to an estimated twelve thousand people, mostly up at Cow Canyon and MSAC in conjunction with my planetarium shows. Several of those observing sessions were advertised in local papers and drew from one to two thousand people each! Cars were parked on Glendora Mountain road and Mt. Baldy road for a good mile down to and past the village.

Comet Hale-Bopp provided another opportunity for large public star parties at Griffith, Cal Tech, and the local area. In 2003, the extremely close Mars opposition garnered a lot of interest, and I had many observing sessions at Griffith Observatory's temporary site at the LA Zoo. (The main observatory was undergoing renovation, and I was filling in for their 12" Zeiss at the temp site) On opposition night, August 26, we had the largest public star party ever held, with over 18,000 attendees! I was the centerpiece with the 11" and had a four hour wait time to look through it. Some 3,000+ people looked through my scope that one night, and I was interviewed on nine different TV stations!

Since then I've set up at several local elementary and high schools every year, most have had me back for many years.

NIGHTWATCH: Is the scope was still mounted on the station wagon shown in the photos.

Actually it's on its third Volvo. The mount will clip onto any model 240. I saw the old Volvo ad where they stacked a half-dozen of them on top of each other to show how strong the body construction was--and took it seriously! I did send Volvo HQ a photo of the scope on the car a couple of decades ago.

This telescope turned out to be more valuable to me than I'd ever imagined. It got me my job at JPL. I simply gave a copy of S&T to my interviewer and had the job immediately! Other than our initial introductions, I literally didn't say a single word during my 'interview', he just read the article and hired me. It also opened the door at Mt. Wilson for me to become the 100" telescope operator (and eventually the 60") In addition I repair and modify the custom eyepieces for the Mt. Wilson scopes.

Here's a really weird coincidence! The telescope at the Sydney observatory in Australia (A late nineteenth century British style structure) is an 11" f/15 refractor very similar to mine. It was built in 1876, exactly one hundred years before mine, almost to the month! The maker of it was a German optician named Otto Schroeder (no relation). Both scopes are the same unusual size built a century apart and sharing the maker's name.

Jeff Schroeder

Here are a few images from RTMC in 1976/77 of me with the objective lens & scope, and the original mount being set up. (A major effort)

"I saw the old Volvo ad where they stacked a half-dozen of them on top of each other to show how strong the body construction was--and took it seriously!" (Jeff Schroeder)

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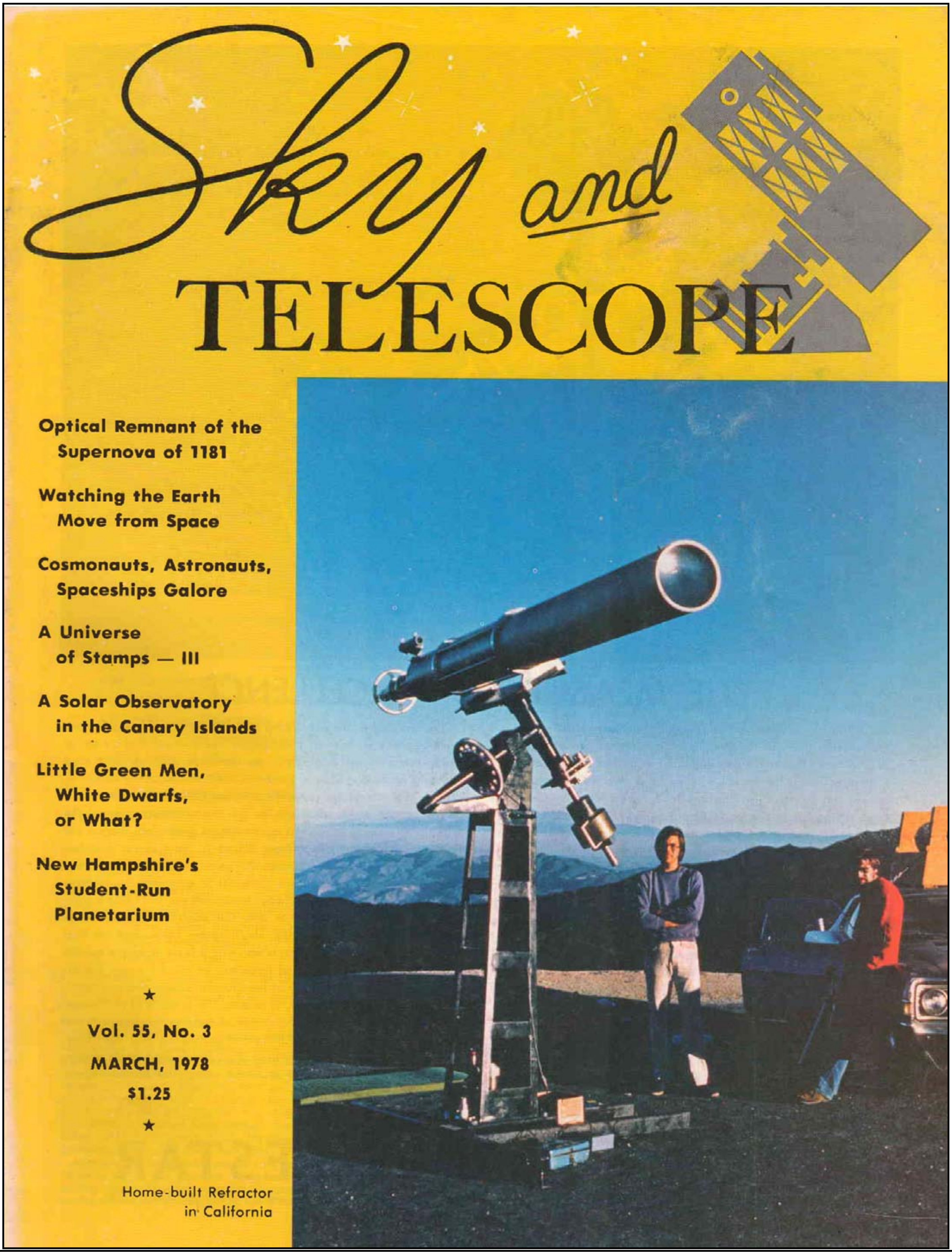
Sky and
TELESCOPE
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MARCH, 1978
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Home-built Refractor in California

GLEANINGS FOR ATM's

CONDUCTED BY ROGER W. SINNOTT

A California Amateur's 11-inch Refractor

I FIRST became interested in large refractors while visiting Yerkes Observatory in Wisconsin during the summer of 1974. That fall I got a job at the planetarium of Mount San Antonio College, near home in Pomona, California. There I signed up for a course in machine-tool techniques and asked the instructor, T. Bruce Clarke, if I could attempt a telescope instead of the regular class project. He agreed, not yet knowing that I had in mind a refractor over 12′ long!

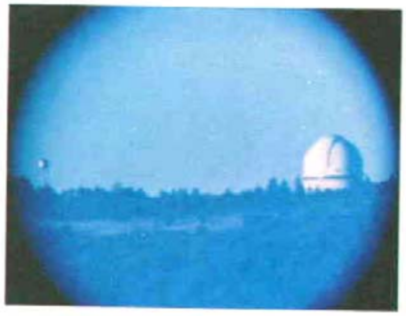
Thanks largely to his advice and patience in the ensuing months, the project has been quite successful. At first all I had were sketches and vague ideas of what I wanted. Detailed plans were never made, because buying raw materials and parts to fit a design would have been much too costly. Instead I relied on surplus materials and solved each problem as it arose. This was my first contact with machine tools and definitely a learn-as-you-go venture.

The most difficult part of the mechanical construction was the clock drive. Over 150 hours were spent in mounting its 10 gears, 16 instrument ball bearings, two differentials, and three electric motors in a 4½″ by 5″ by 7″ space in the top of the 6½′ pier. The latter is a welded structure of angle iron and ¼″ to ¾″ steel plate; calculations show that the pier will support over seven tons.

Like the polar shaft (pictured on page 259), the declination axle is a tapered piece of mild steel, 3″ in greatest diameter and 50″ long. Its housing is ½″-thick steel tubing welded to a shorter piece of the same material to form a tee attachment on the upper end of the polar shaft. The tee was machined and welded in one setup to provide a right angle accurate to one minute of arc. This critical weld was the only part of the work I did not do myself.

The 12′-long aluminum irrigation pipe that holds the optics was found lying in a railroad yard — quite a bargain at $30! Two specially made 9/16″ by 12″ bolts hold the tube to the mounting for easy removal. The 200-pound tube assembly is counterbalanced by a 100-pound brass-clad steel weight and an adjustable 30-pound steel weight.

With the mounting nearly finished, I still had doubts about being able to make the achromatic doublet of a large refractor. In May, 1975, I obtained a 15″ disk of BK7 crown glass at the Monterey Park Astronomical Society's annual swap meet. I had no way to ascertain its quality, so I took it to Coulter Optical Co. in Idyllwild. They agreed to trade my disk for another



Palomar Mountain is clearly seen through 27 miles of atmosphere in this picture taken at Idyllwild, California, by Jeff Schroeder with his homemade 11-inch refractor. (See also the front cover of this issue.)

BK7 blank of 11″ diameter and known grade-A quality.

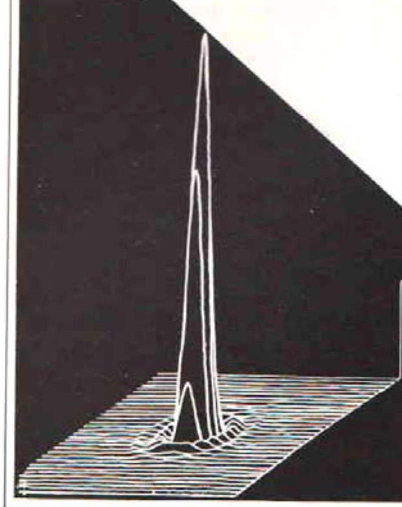
Then six weeks later Coulter called and told me of a 13″ grade-A disk of F2 flint that I could have for what it had cost them, $125. This disk had been rejected by NASA because of an improperly molded curve. Ironically, if I had kept the original crown disk I could have made a 13-inch telescope, but Coulter no longer had the big blank!

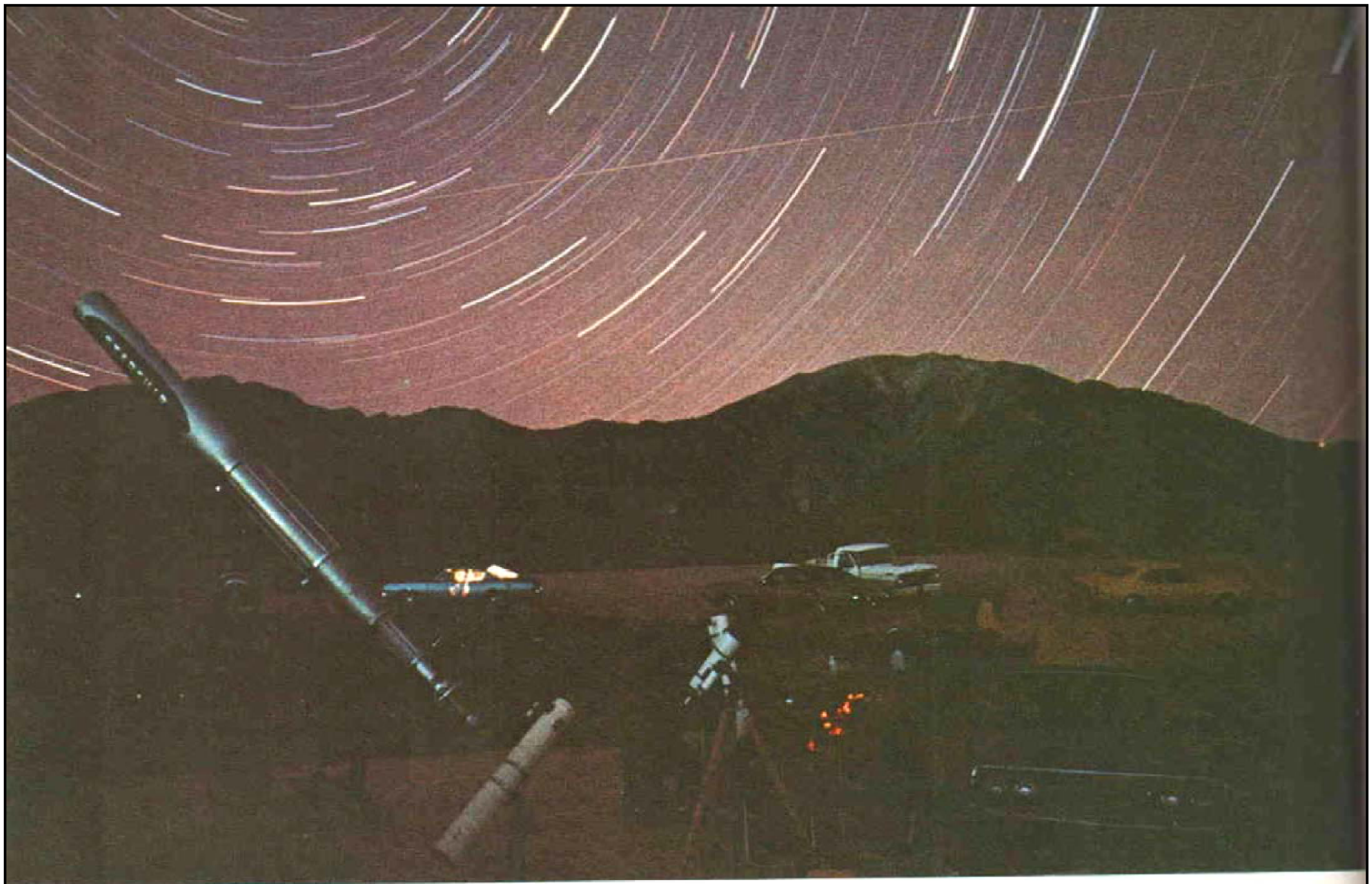
Before working the glass disks I needed a design and began reading the chapter that starts on page 106 of *Amateur Telescope Making — Book One.* Around this time, a friend told me about a course on optical design and fabrication being given at Citrus College in Azusa. I enrolled in the class and showed some initial calculations to the instructor, James Kent. He noticed flaws almost immediately and helped me revise the numbers, then ran them through an optical optimization program on the school's computer. The resulting design has negligible coma.

Here are the final specifications in inches, where negative radii of curvature are concave to the sky and surfaces are listed in the order light passes through them:

Crown element (Schott BK7):	
First surface	+112.32
Center thickness	1.00
Second surface	−63.91
Air space	0.554
Flint element (Schott F2):	
Third surface	−63.88
Center thickness	0.80
Fourth surface	−272.00
Back focal length	186.30
Equivalent focal length	188.48

In the optics class I was able to diamond-generate and edge both blanks and a tool for the first surface. Edging the 13″





Above: Soon after completion, the 11-inch was set up at Glendora Ridge in the San Gabriel Mountains for a star party in late November, 1976. Tokuo Nakamoto's 80-minute exposure shows the trails of northern stars and an earth satellite.

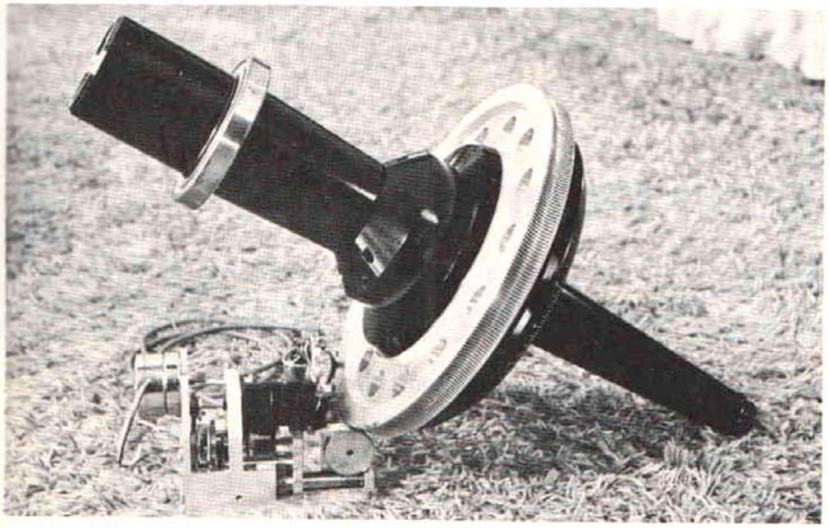
Below: The author has just arrived at one of his favorite observing sites, a little over a hundred miles east of Los Angeles. The telescope, mounting, and trailer together weigh about 1,200 pounds.

flint down to 11" was painful to watch — a lot of valuable glass going down the drain! The course ended just as I was ready to rough grind the crown disk, so I did all further optical work at home with no other guidance than *ATM-1*.

First a suitable grinding stand had to be built. A 1"-thick 2'-square piece of plywood was supported at waist level by a heavily cross-braced structure of two-by-fours. A narrow wooden ring was turned on a lathe and fastened to the table with glue and nails. This ring could hold any blank on the table (with a convex side down if need be) while another blank was being worked on top. The inner shoulder of the ring was lined with rubber.

In making large lens elements, a centering jig and a spherometer are almost necessities. The latter is used to keep track of the radius of curvature of each surface, and the former to monitor the wedge or difference in thickness around the rim. I made both of these instruments in the Mount San Antonio College machine shop.

The centering jig has three support pins on which a blank is laid horizontally, and two alignment pins against which the rim is placed. A dial gauge is mounted verti-



The telescope's polar shaft is a 30"-long piece of mild steel, tapered to fit a 4 1/8"-inside-diameter upper bearing and a 1 3/8" lower. These are high-quality surplus (but never used) jet engine ball bearings. The shaft has been hollowed out but still weighs 80 pounds. Note the 14" aluminum worm gear, mounted almost centrally. The author devoted a month to cutting its 360 teeth on a Milwaukee universal milling machine with a homemade gear hob; the gear and mating worm were then lapped at high speed for three hours with two grades of fine optical emery. The drive has proven quite accurate.

cally so that its plunger meets the upper surface of the lens just inside the rim. By taking readings for many orientations of the lens, the amount and direction of its wedge can be determined. My jig is similar to those pictured on page 247 of the April, 1971, issue of this magazine.

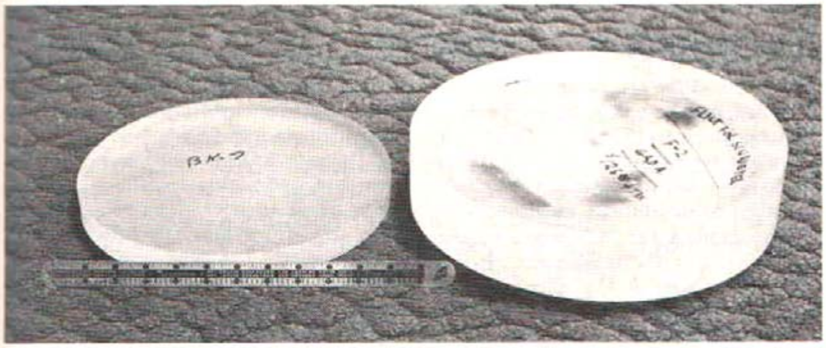
A machinist's micrometer became the central measuring screw of my spherometer. The hardest part of the construction was machining identical hemispheres on the ends of three legs and locating them 120° apart on a 3"-radius circle scribed on the spherometer frame. Great pains were taken in this work so that I could use standard optician's tables, without further correction, to obtain the radius of curvature from the depth readings of the screw. I borrowed a small optical flat to determine the zero point of readings with this spherometer.

Because the generated curves of the first lens surface and tool were already quite close to those desired, I could begin grinding with 220 grit. The standard one-third diameter center-over-center stroke was used most of the time, but lengthened or shortened whenever the radius of curvature (as indicated by the spherometer) drifted away from 112". Grinding was completed with grit sizes 400 and 600.

The second and third surfaces were ground on each other, saving one full sequence of operations. Then the flat back of the tool was made slightly concave by grinding with some scrap plate glass until it fitted the shallow curve of the fourth surface. It took two months of spare summertime hours to prepare the four surfaces for polishing. The first three were within ½" of the design radii, and the weak fourth curve ended up about 10" longer.

During each grinding stage, I strove to reduce the wedge by at least half the value remaining from the preceding stage. The initial diamond-generating had left the crown with a wedge of 0.011" and the flint with 0.013". The final readings were 0.0005" and 0.0008", respectively, which is better than the 0.0011" tolerance specified by the computer. The high point of each element was marked for later reference.

Ready to polish, I attempted to make a pitch lap on the deep side of the glass tool. This was disastrous — the tool cracked under the heat and hot pitch ran all over my left foot. A week later, at the machine shop, a large sheet of aluminum tooling plate attracted my attention. I cut two 11" aluminum circles and turned a gentle concave curve on one and convex on



The two disks of optical crown (left) and flint glass, as received by the author. Much material was removed from the flint in subsequent shaping.

the other. The curves were done freehand on the lathe and were left rough so that the pitch would adhere well. It was a pleasure to form laps on the thin aluminum; I could just heat a disk on the stove until it was very warm and pour hot pitch on it without fear of cracking. A masking-tape dam kept the pitch in place, and before it had completely cooled I pressed a lens blank on it to form the curve. A commercial rubber mat was used to provide facets.

After polishing for a few days, I discovered that I merely had to dip a lap into a sink of hot water for a few seconds before hot-pressing it against a lens. The aluminum backing absorbed and lost heat so readily that polishing could resume a minute or two later. I had no problems with pitch cracking from expansion or contraction of the aluminum. During polishing, the metal would reach the temperature of my hands quite rapidly, but I was using fairly hard pitch and had no trouble with these warmer-than-normal laps. With fast-acting cerium oxide, each surface came to a complete polish in about eight hours.

The lens cell had to be made before figuring could begin. It was machined from an aluminum ring 12″ in outer diameter and 1″ thick. The retaining ring was turned and threaded on one end of the main casting, then parted off so that the rest of the cell could be finished. The lens elements fit in the cell with a clearance of 0.002″, which is taken up with masking tape to avoid glass-to-metal contact. The tape also allows slight thermal contraction of the cell without pinching the glass — a problem discussed by Robert E. Cox in the October, 1973, issue, on page 256.

After assembling the lens, I had to devise a way of testing it. A large optical flat was unavailable for autocollimation, so for a source of nearly parallel light I settled on a distant streetlight. From high ground five miles north of my house, numerous sodium-vapor lamps could be seen, far enough away to act as starlike monochromatic sources for testing with a Ronchi grating. But the air was often unsteady, and this hilltop test site could only be used on about half of my trips up there.

The first trial of the lens showed a smooth, somewhat undercorrected figure. I was pleased that the aluminum-backed laps had worked so well. I decided to do all figuring on the concave third surface, the only one that could be examined by normal methods at home.

Center-over-center strokes were used throughout. A velvety smooth surface was seen in the Foucault test after almost every figuring spell, and I found the curve easy to control. Rather than vary the stroke length, I found that applying pressure to the center of the lap or to its edges would cause sufficient flexure of the aluminum backing to produce a localized but blended polishing action, rapidly hollowing the center or flattening the edge. I have since used this technique on 12-inch and 4-inch mirrors and can highly recommend it.

During figuring, the lens as a whole went from its original undercorrection to moderate overcorrection, traceable to an oblate spheroid put on the third surface while I was learning to control the lap. Eventually a mild ellipsoid on the third surface completely removed the spherical aberration of the assembled achromat in artificial star tests.

There was less secondary chromatic aberration than I had expected, but some axial astigmatism. The latter was reduced by rotating the lens elements upon each other, the best position happily being near that where the residual wedge of the elements cancels out. The color correction can be changed by varying the spacing of the elements. A little experimentation showed that the best spacing was indeed the 0.55″ called for by the design.

The lens resolves 0.6-second-of-arc double stars, and shows dark sky between the components of a one-second double under good conditions. It does not quite reach the Dawes limit (0.4 second) because of residual astigmatism, perhaps due to uneven support during polishing. At very high magnification the diffraction pattern is triangular, but this imperfection does not show below 300x. The lens is my first optical endeavor, and I am completely satisfied with its overall performance.

Three evenly spaced light baffles inside the main tube define an illumination cone 3½" across at the focal plane. An aluminum and brass eyepiece holder increases the tube length to 15'. A large aluminum ring (best seen in the front-cover photograph) provides a convenient handhold, and when rotated focuses the telescope.

I have made a giant achromatic eyepiece with a field lens 3¼" in diameter. It gives a 1° field of view at 51x, allowing me to observe large objects not normally visible in their entirety with a refractor of this size. It shows faint but definite colors in the Trifid nebula (M20) in Sagittarius, and the spectacular extent of the great nebula in Orion. With this eyepiece the 11-inch becomes a huge rich-field telescope!

Worthwhile observation is almost impossible at my home in the city. I regularly take the 11-inch to such places as Joshua Tree National Monument, Big Bear (for the annual Riverside convention), Palomar Mountain, and my favorite location near the mountain town of Idyllwild.

Moving a 1,100-pound telescope is not very easy, and setting up or dismantling it takes about an hour. The heavy mount, pier, and tip-resistant base fit on a homemade trailer. The tube goes on a rack atop the car. It must be quite a sight going down the freeway, where I receive lots of stares from the other drivers.

Eventually, I hope to find a permanent observatory site. A large Littrow spectroscope is being made to permit observing stellar spectra with this 11-inch refractor.

JEFF R. SCHROEDER
252 Royal Coach Ave.
Pomona, Calif. 91767

Last June 12th, the author took this remarkable photograph at the prime focus of the 11-inch refractor, showing Mount Wilson Observatory 87 miles northwest of the Idyllwild site. Note the outlines of the 60- and 150-foot solar towers, and the domes of the 60- and 100-inch reflectors.

FOCUS ON

Cedarville College
Cedarville, Ohio

This college observatory, located on campus, houses a 16-inch Cassegrain reflector with an effective focal length of 256 inches. The equatorially mounted instrument and drive system weigh approximately 3,200 pounds, exclusive of auxiliary instrumentation.

The observatory is intended both as a general-purpose facility for beginning astronomy courses and visiting groups as well as providing the basic instrument for a limited amount of research using special equipment. A photoelectric photometer and a recording polarimeter are available on campus for specialized studies of eclipsing variable stars, planets, and other solar system objects.