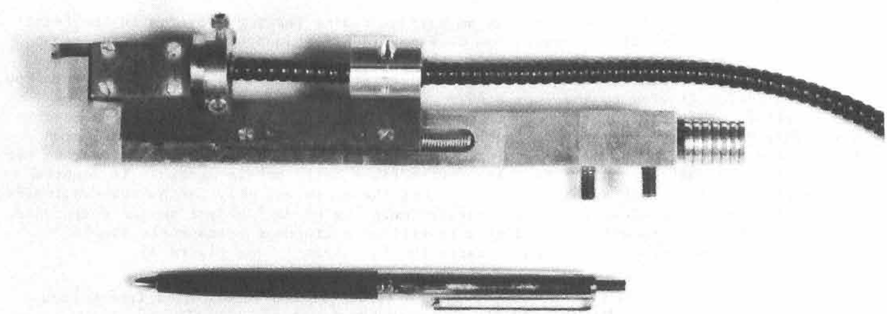

Fig. 1. Side view of one of the four arms which carry the apertures. lenses, and fiber optics to the focal plane.

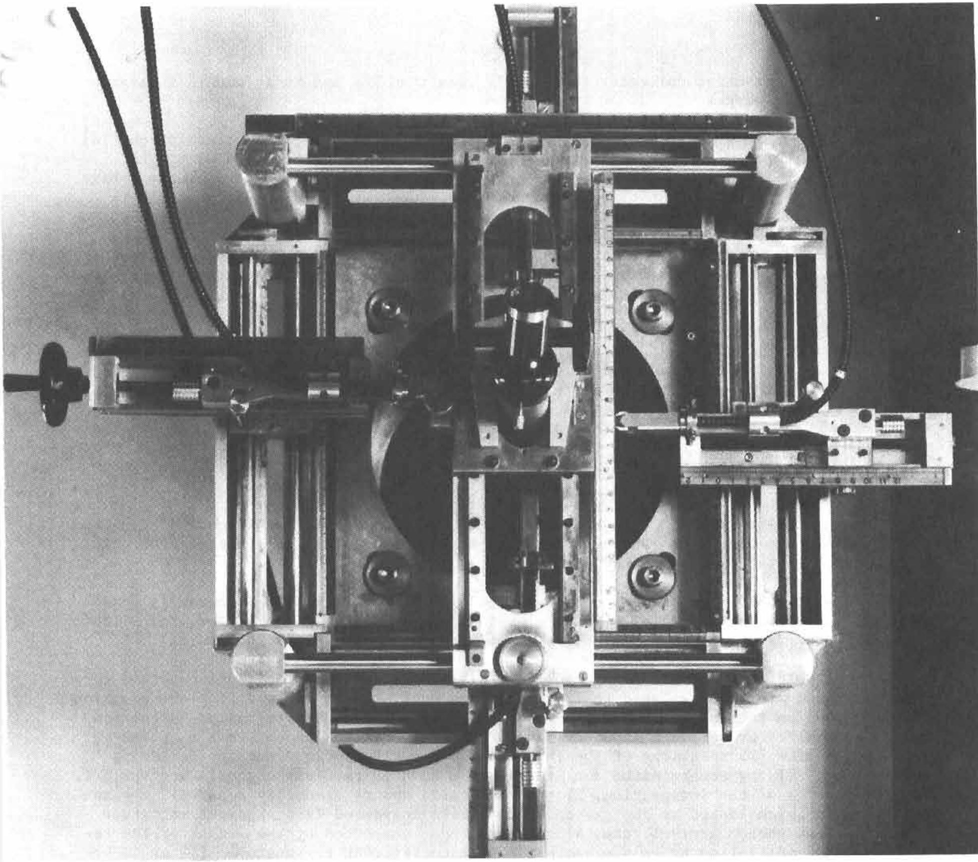

Fig. 2. The four XY-arm assembly for positioning the apertures in the focal plane.

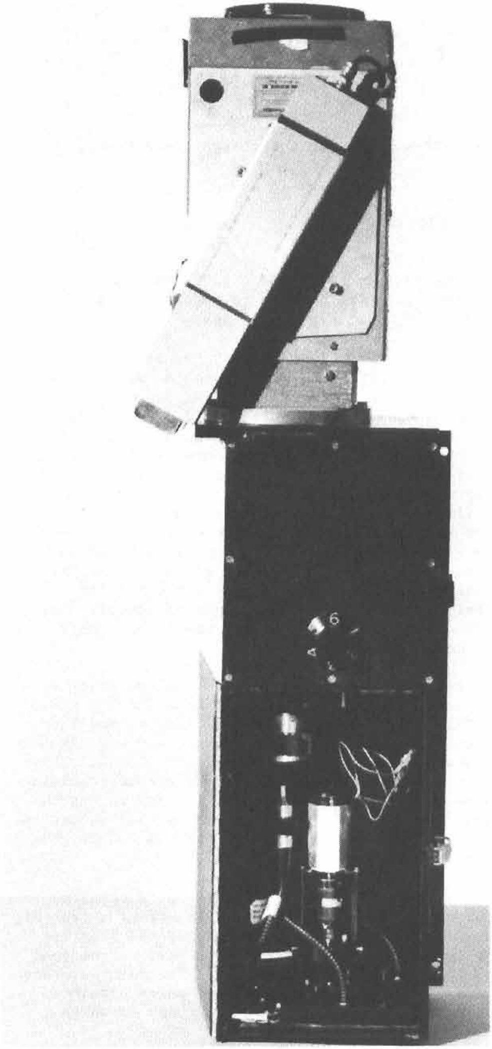

Fig. 3. The open Chopper Box showing the 4-into-1 fiber-optic adaptor, the motor which drives the chopper with its flexible drive, the P.F.R. cooler, and the P.A.R. preamplifier/discriminator.

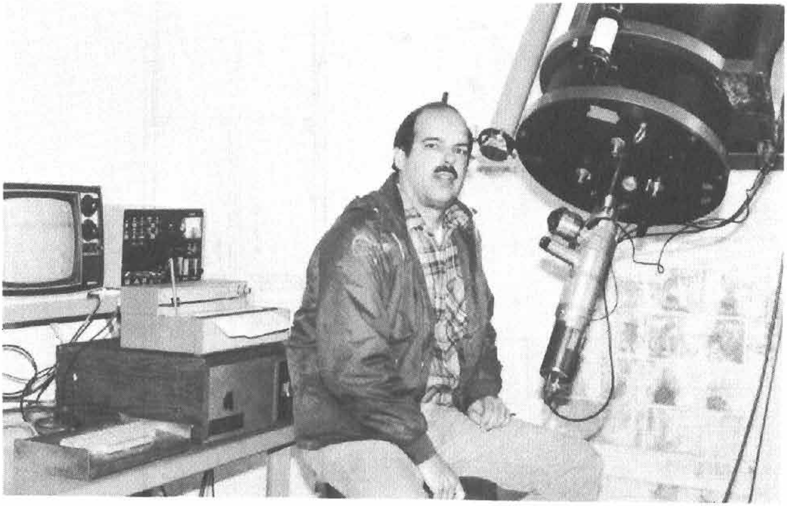

Fig. 5. Photograph of the entire system installed on the author's 16-inch telescope. The amplifier/discriminator is contained in a small box mounted just under the phototube. Cables (25' long) for high voltage, photon pulses, and discriminator power are routed across the floor to the telescope pier.

unaluminized cover glass. While most of a star's light is transmitted to the PMT, approximately four percent, per surface, is reflected into the previewing eyepiece where it can be tracked. This "poor man's" substitute to offset guiding has worked well as long as the star is at least three magnitudes brighter than the telescope's threshold. For fainter stars, there is no substitute for an accurate polar axis alignment and a good clock drive.

Amplifier/Discriminator

The amplifier/discriminator, mounted very close to the PMT output, was made by a now defunct company on Long Island. Fortunately, an equivalent (and cheaper) unit can be made using the LeCroy MVL-100 integrated circuit. A design using this chip has been described

When an interrupt from the counter/timer is received, the microprocessor calls to the interrupt processing routine to retrieve and store the count data (3 bytes). In addition to gathering and storing the count data, several real-time displays can be provided by the computer (comtrolled by the keyboard):

(1) Decimal display, on the monitor or printer, of the total counts per integration. This not only eliminates the need for readouts on the counter, but it enables the simultaneous display of many consecutive integrations.

(2) Graphic plots of counts on the screen or a printer.

(3) Chart recorder output (requiring digital-to-analog conversion of the binary count word, appropriately scaled in software).

Figure 7 illustrates two of these displays: (1) the chart recorder provides a hard-copy record of the data as well as notes written by the observer, and (2) a real-time video display (scrolling vertically) of the data being gathered. Also shown is the photon counter box itself, including high-voltage power supply. (Note: Many of the controls shown on this box are not needed for the simpler design described here.)

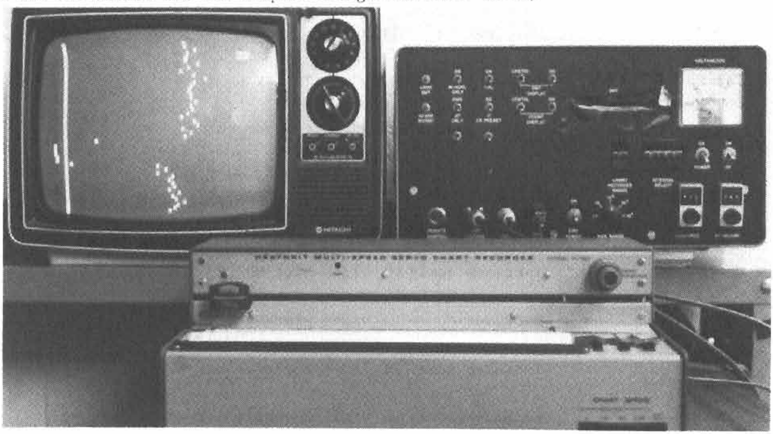

Fig. 7. Close-up of three of the elements in Figure 5. The photon counter is housed in the black box. Many of the controls and functions shown were developed prior to using the system with a computer and are no longer necessary. The computer video monitoris displaying stored count data (scrolling vertically) while the chart recorder is used to supply a real-time data map and to record notes.

The alternate approach, a prototype board which fits into the computer card cage and has direct access to the computer bus, has a number of advantages:

(a) There is no need for a separate box.
(b) Power is readily available.
(c) The computer addresses and data busses can be directly accessed.

The big disadvantage of this alternative is that additional circuitry to decode addresses and process the interrupt must be provided in the counter/timer design. For this reason, use of a separate box and parallel input port has been assumed.

(2) Boards and Card Cage: A number of different boards and card cages are available. I prefer boards designed for soldering which have interlaced power and ground metalization strips (Figure 12). Wire wrap is an alternate technique finding increasing acceptance. Probably the best approach to selecting a configuration is to visit a local computer products distributor or send for catalogs. (Many computer stores are disappointing for "nuts and bolts" purchases - they often sell only turn-key systems and software.)

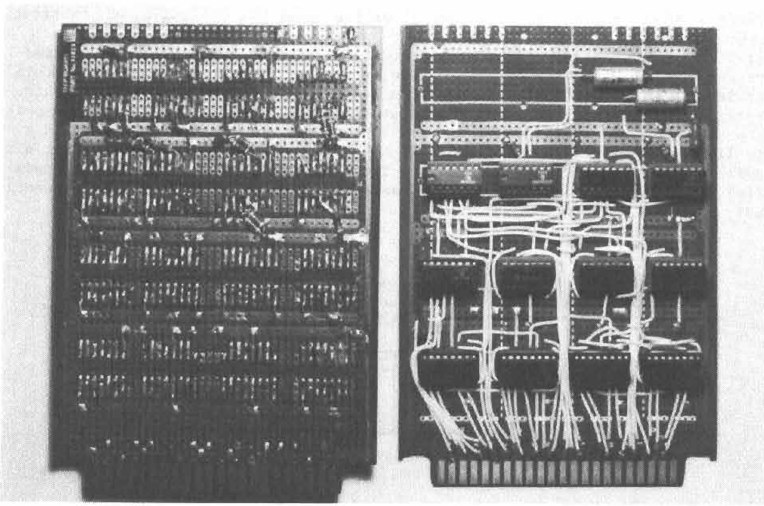

Fig. 12. Typical solder circuit boards - note that IC'c are all in sockets.

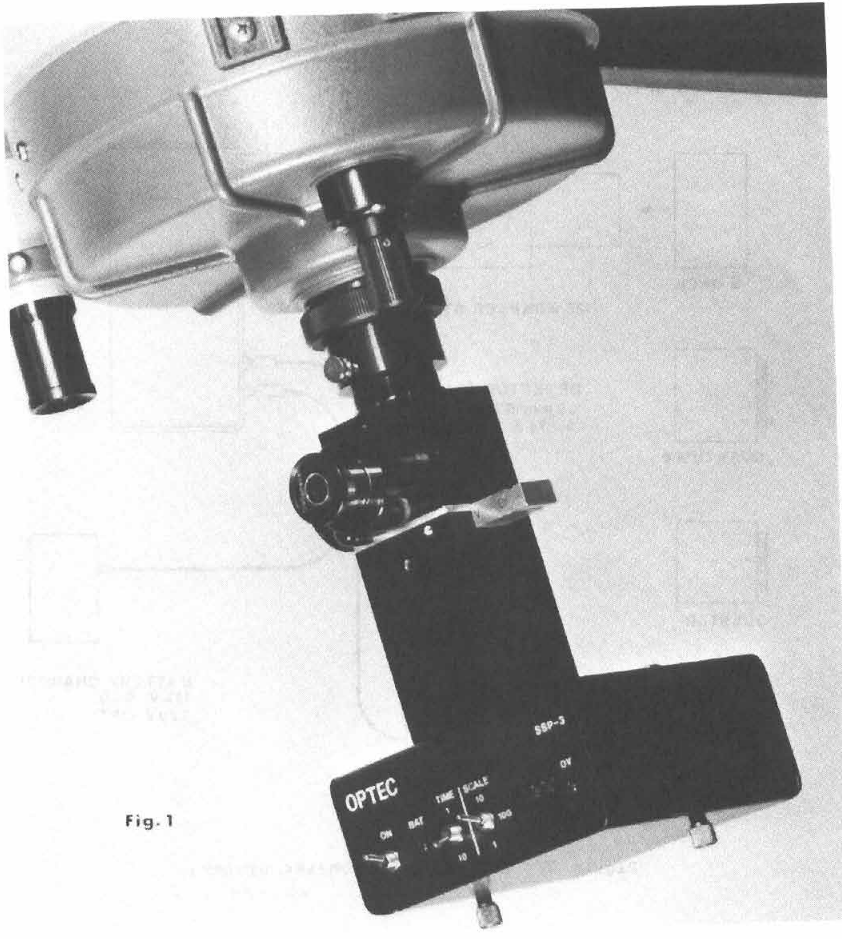

Fig. 1

Figure 1. This view shows the telescope tube assembly with the photometer head attached, the laminated plywood fork and the fabricated drive unit. In the background are the supporting electronics and the chart recorder.

Figure 2. Looking through the observatory door, one sees the telescope and its mount. On top of a roll-around cabinet are the electronics and chart recorder. Electrical outlets are located on the observatory sidewalls as shown.

Figure 3. Rolling Ridge Observatory as it sits in my backyard. The peaked roof design was selected to accomodate snow loadings and to complement other structures in the neighborhood.

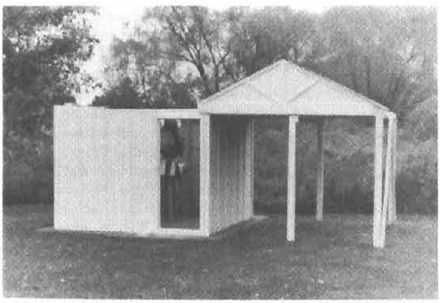

Figure 4. The observatory is shown opened. Through the door, the telescope and mount can be seen. The area around the outriggers can be enclosed to make a warm room or storage area.

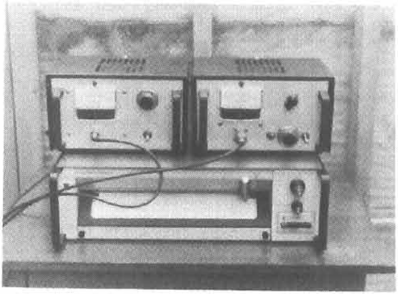

Figure 9. The power supply and amplifier sit on top of the strip chart recorder for convenience during observations.

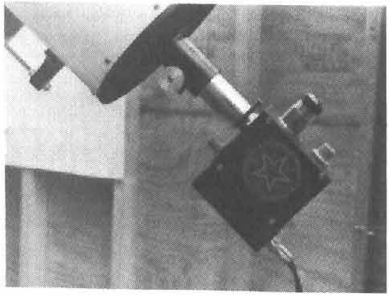

Figure 10. The completed photometer head is shown attached to the telescope. The control knobs and cables are conveniently placed during observations

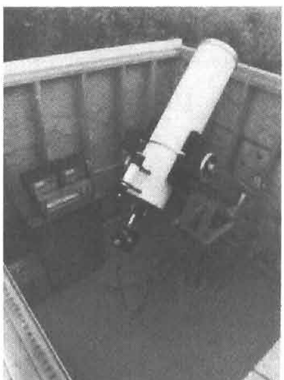

Figure 11. Looking down from the roof of the observatory one gets a complete view of the system. This compact observatory allows efficient use by one or two people while observations are being made.

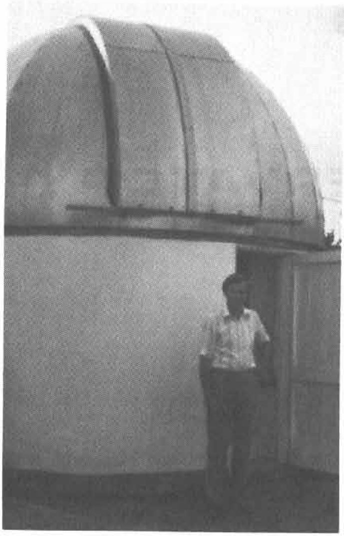

Figure 1. The author stands outside Nigel Observatory.

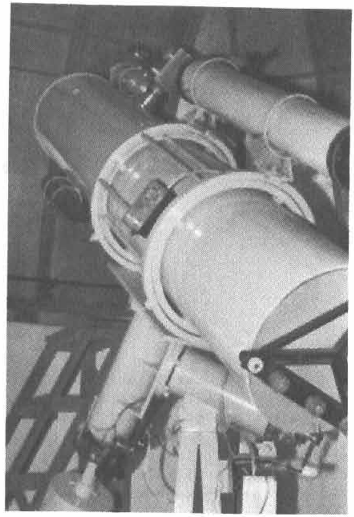

Figure 2. The 12½" f/6 Newtonian telescope is shown.

The photometer shown in Figure 3 is of conventional design. That is, light from the telescope is collimated by a Fabry lens and passes through the appropriate filter before falling on the photocathode of an EMI 9781A side-window photomultiplier tube. The signal is carried to a DC amplifier whose output is converted to a digital display by an Intersil 7107 A/D converter. The DC amplifier also has output for a strip chart recorder and a BCD output which can be interfaced with a microcomputer. The HV power supply is modelled after the design by Stokes which was described in the previous chapter (see Figures 4, 5, and 6).

The observing program now consists mainly of variable star measurements. A total of 87 stars is currently being observed, mostly with very far south declination to take advantage of the dark skies to the south of the observatory. With the help of Dr. Hall, a number of stars have been selected for observation, including suspected variables and RS CVn type stars.

As a matter of interest, there are no plans to use the photometer for timing occultations. Plans for the future include semi-automated data acquisition and processing utilizing a microcomputer, and possibly automated object acquisition using setting circle encoders and the microcomputer.

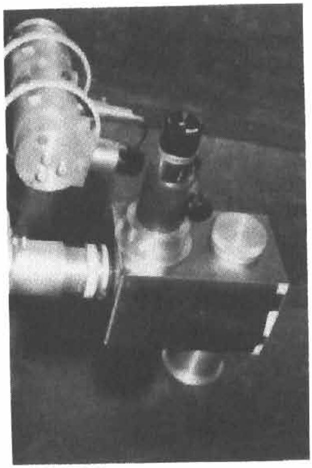

Figure 3. A close-up view of the photometer head.

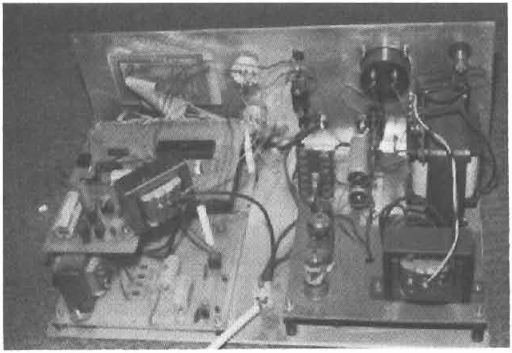

Figure 5. A view of the electronics with the cover removed. the HV power supply is to the right, the DC amplifier to the bottom left, and the A/D converter board to the top left.

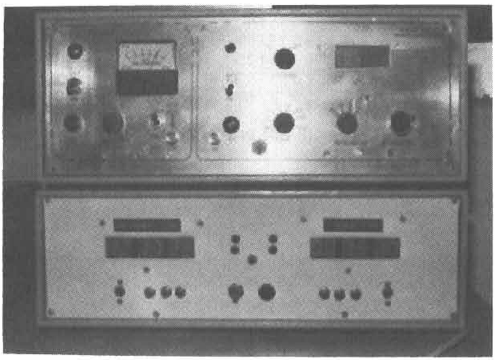

Figure 6. The photometer electronics package is shown standing on top of the observatory clocks.

Thanks tothe help from several companies, institutions, and private persons, this observatory is now working very well. If it were not for their willingness to help, this venture would have been a total loss.

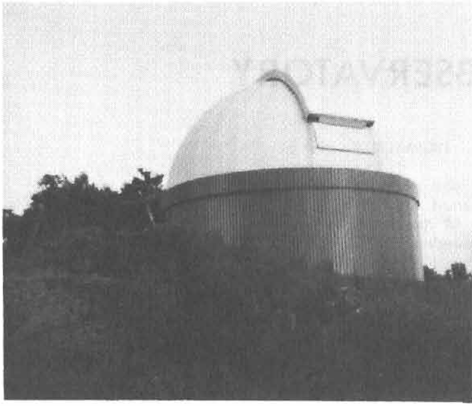

Fig. 1. The 20-foot dome of T.A.O. Observatory covered with masonite and fiberglass resin.

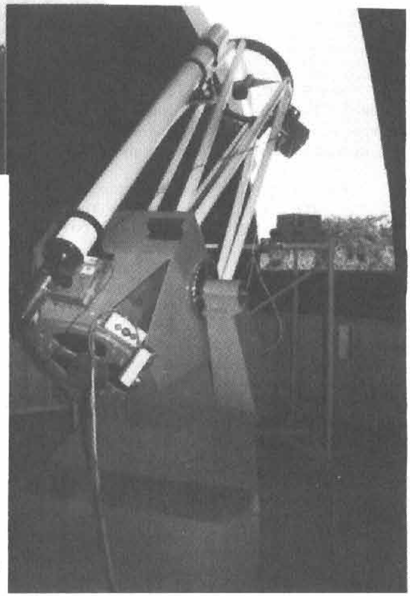

Fig. 2. T.A.O. Observatory's 14-inch f/7 Newtonian/Cassegrain telescope, with 5-inch refractor finder and control boxes.

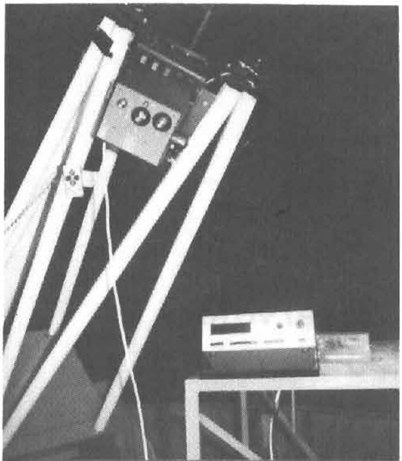

Fig. 3. The STARLIGHT-1 photometer head mounted at the Newtonian focus. The Head shows the Aperture and Filter controls (6 positions each), the View/Count switch, and the post-viewer eyepiece holder. The STARLIGHT-1 photon counter is sitting on the table.

Fig. 4. A close-up view of the STARLIGHT-1 photometer head.

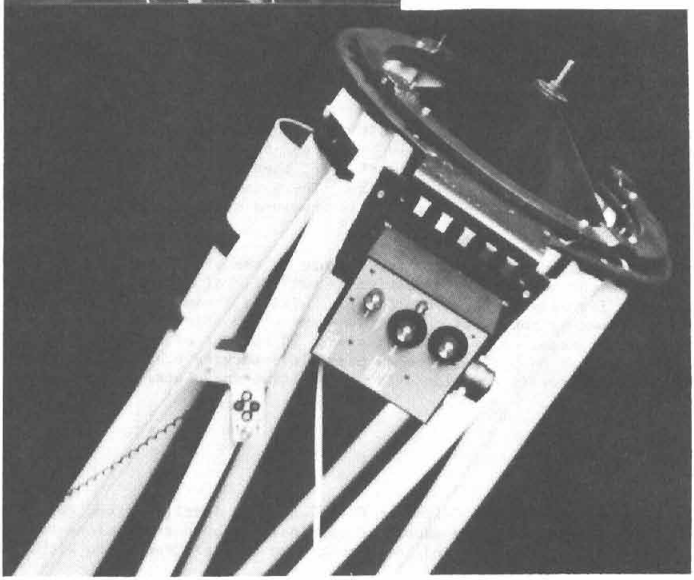

Figure 1. The Johnson Observatory is shown stored ia a corner of the garage when it is not in use.

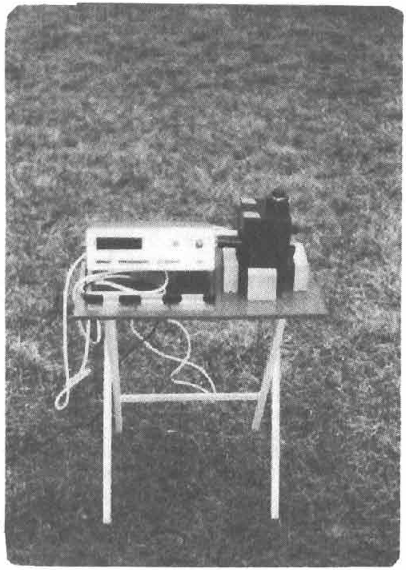

Figure 2. The EMI STARLIGHT-1 photon counting photometer is shown on the reinforced serving tray which permits ease of portability and set-up.

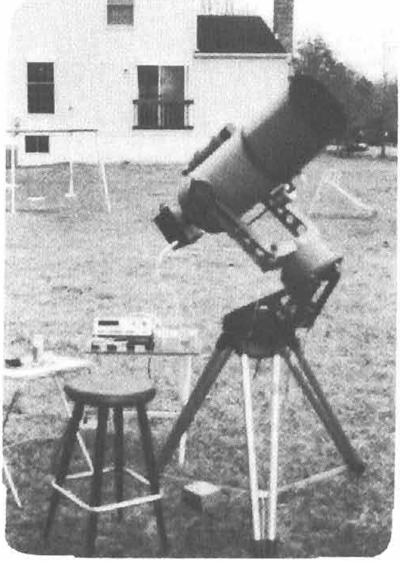

Figure 3. The complete system is shown set-up and ready for photometric observations.

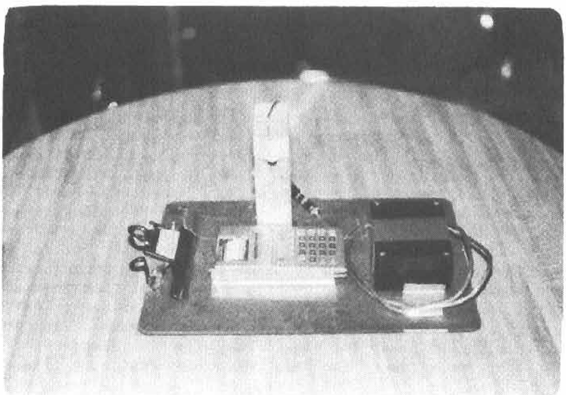

Figure 4. The Radio Shack EC-3008 Calculator mounted on a clipboard.

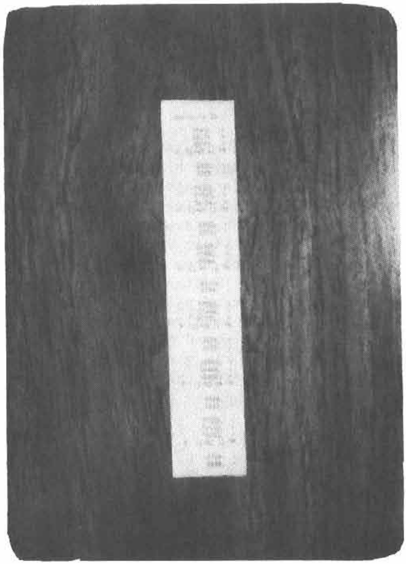

Figure 5. A sample printout from the Radio Shack calculator.

Figure 6. The complete data reduction system of Johnson Observatory.

VI. CONCLUSION

As you can see, it is not necessary to have a permanent observatory with sophisticated supporting equipment to seriously engage in one of the branches of astronomy. With a little planning and organization the amount of time needed to set up and get going can be greatly reduced. Although the use of microcomputers for data reduction and plotting of photoelectric photometry measurements are not essential, they are very helpful and should be considered.

Figure 7. The author is shown sitting "in" Johnson Observatory. Everything is designed for convenience during long observation runs.

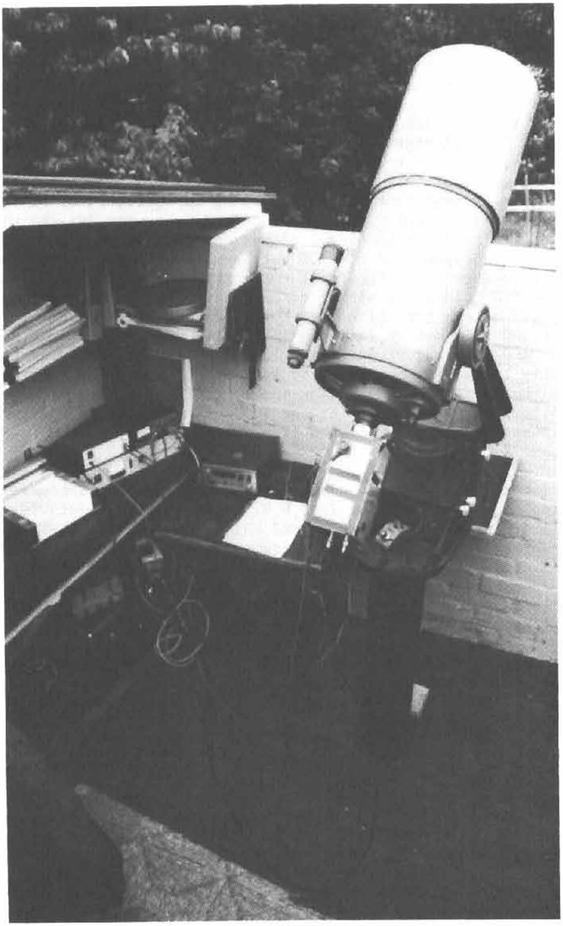

Figure 2. The Mouldsworth Observatory Celestron 11-inch telescope, photometer, and ancillary equipment.

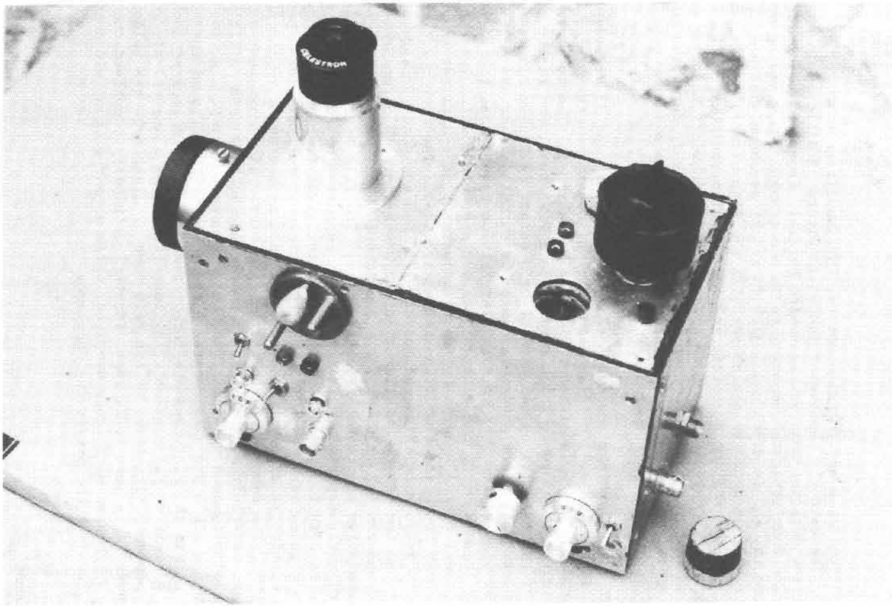

Figure 3. The Mouldsworth Observatory photometer head with dry ice cryostat in place.

V. AMATEUR PHOTOELECTRIC PHOTOMETRY IN ENGLAND

Weather conditions in England are not very favorable for photometric observation, with usually only 20 - 30 "near-perfect" nights per year. Despite this fact, a number of other advanced amateurs in the U.K. are now assembling photoelectric equipment for use with their own telescopes. The author is in close cooperation with some of these, in particular, Mr. Andy Hollis (pictured with the author in Figure 10) of Cuddington, Cheshire, John Watson of Hartfield, Sussex , and Roger Pickard at Hadlow in Kent. A number of other British amateurs, most notably Patrick Moore, are planning on "going photometric".

Figure 10. Andy Hollis (on the right) and the author - pioneers in amateur photoelectric photometry in England.

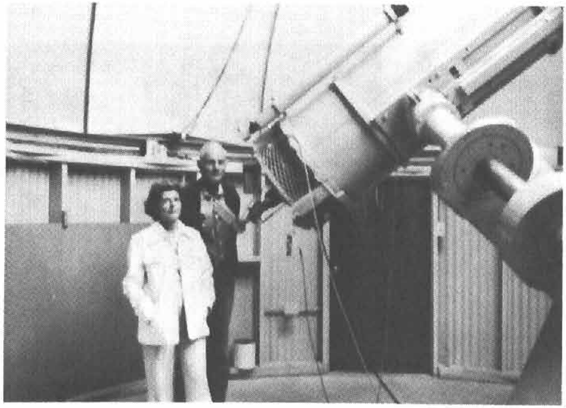

Fig. 2. Helen and Richard Lines stand beside their
20-inch Newtonian/ Cassegrain telescope.

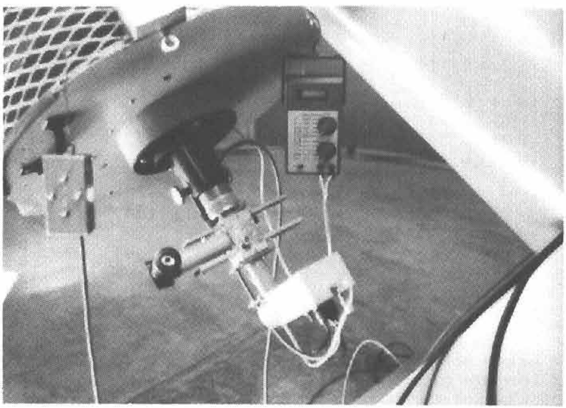

Fig. 3. The Lines' photometer attached to the Cassegrain
focus. The telescope slow motion controls hang from the telescope.

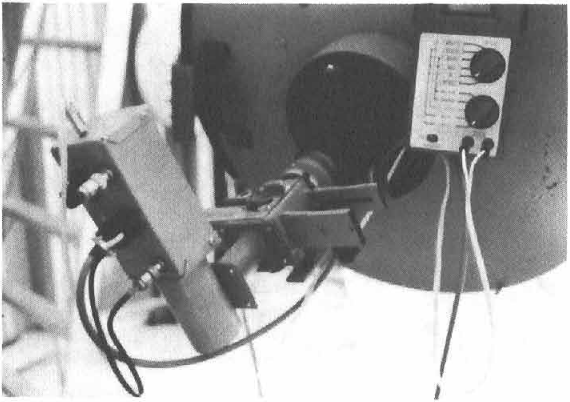

Fig. 4. A close-up view of the photometer head and digital readout voltmeter.

LINES OBSERVATORY LATITUDE : 34 23 44 LONGITUDE : 112 14 19

VARIABLE NAME : TX U MA R.A. : 10 44 21 DEC. : 45 39 20
COMPARISON NAME : BD +47 1797 R.A. : 10 39 05 DEC. : 46 55 41
UNIVERSAL DATE : D/M/Y 30/3/83 PERIOD: 3.063243 EPOCH 2445384.1238

UT	v	b	u	s	s	s	JD(HEL)	PH	DIF V	DIF B	DIF
3 13 0	116	151	0	4	4	0					
3 19 0	145	234	0	5	5	0	5423.64144	.9005	-.226	-.454	
3 24 0	120	156	0	5	5	0					
3 28 0	152	240	0	6	6	0	5423.64769	.9026	-.272	-.482	
3 31 0	118	152	0	6	6	0					
3 35 0	153	239	0	7	7	0	5423.65255	.9042	-.295	-.528	
3 39 0	118	144	0	8	8	0					

Fig. 5. A sample printout of the reduction program. The input readings for each filter are on the left, followed by the sky readings. The time is the mean time for the filters. Differential magnitudes are determined using the average of the two comparison magnitudes on either side of the variable magnitude.