THE POLAR AXIS TELESCOPE OF THE MAPLE OBSERVATORY

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Abstract

This paper describes the author's polar-axis refractor, and the advantages and disadvantages of using it. The main disadvantage is the limited field of view. The advantages include the observer's indoor comfort during cold weather, and an extremely stable support for accessories, since balancing is unnecessary with a fixed-axis instrument. The author's observing programs are also briefly described.

1. Introduction

The Maple Observatory in Maple, Ontario, started in the late 1950's as a small, frame, backyard building with an 8-foot plywood dome, housing first a 4-inch Unitron refractor and then a home-built 6-inch refractor with a Jaeger's objective. The polar telescope was installed in this observatory in 1965. In the late sixties a new wing was added to the house which incorporated a two-story brick observatory supporting a 12-foot aluminized steel dome containing twin-mounted 8-inch f/15 and 6-inch f/10 refractors. The heated ground floor provided desk and shelf space and room for the polar axis refractor in the south wall.

In the 1950's, Maple was a small farming community about 25 miles north-west of Toronto with beautifully dark skies. Today it is engulfed in an urban sprawl of 4.5 million people with resulting maximum light pollution. When sodium lights on tall poles were installed on our street in 1991, it was necessary to replace the large refractors with a 10-inch Schmidt-Cassegrain, whose stubby tube could more easily be shielded from the light.

2. The telescope

An 8-inch, 1/10th-wave flat feeds a 4 ¼-inch, f/10 Jaeger's cemented achromat. Instead of using a separate coelostat, as is common with polar telescopes, the flat is hung in a yoke attached to the bottom of the telescope tube. The entire structure rotates as a single unit, the bottom end supported in a heavy radial thrust bearing and the top in a ring bearing at the point where the tube narrows to 2½ inches in diameter (see Figure 1).. This arrangement avoids the field rotation which plagues polar telescopes, since any equipment attached to the tube rotates along with the mirror, making it possible to do long-exposure photography (at least until light pollution made this impossible).

The eye-piece end is centered in a console in the observing room (see Figure 2). This console holds the drive, the manual declination controls, and the setting circles and related electronics, as well as the upper bearing. The R.A. circle is 17 inches in diameter, and declination is set by a geared vernier which reads to 10 minutes of arc. With such a system a finder is not necessary. The 133-tooth R.A. worm gear is 4¼ inches in diameter, half an inch thick, and is mounted around the tube just below the upper ring bearing. A 1-rpm synchronous motor with a 10-tooth gear drives a 108-tooth pinion, which in turn drives the worm. This gives a reduction ratio of 1/1436.4, slightly slower

Figure 1. Outside view of the Maple Observatory polar telescope, showing two of the covers. The shaft controlling the mirror in declination is visible on the right arm of the yoke, and the lower thrust bearing is visible at the bottom. One of the azimuth adjusting screws can be seen at the bottom of the box, and the access hatch is at the top left.

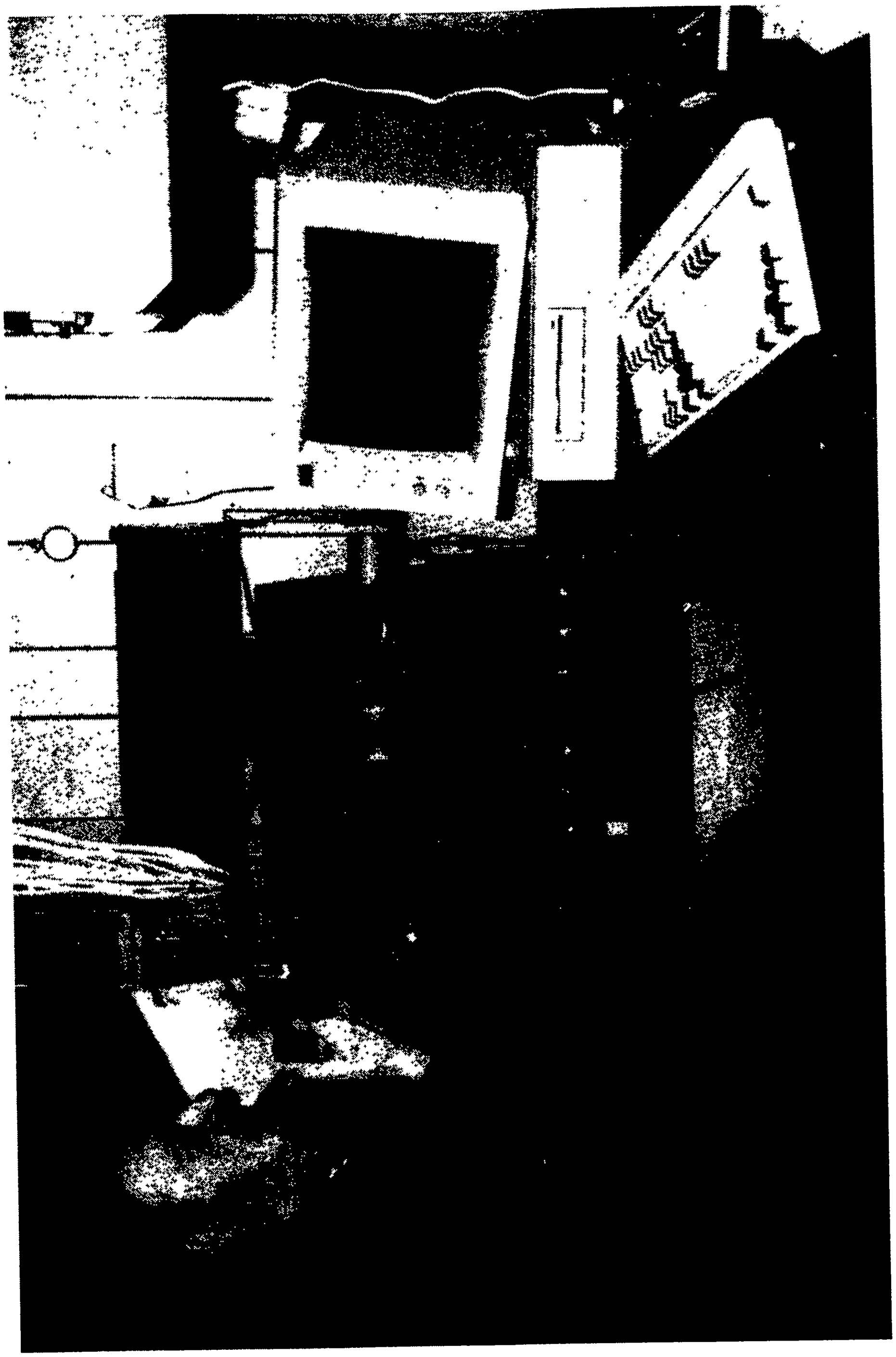

Figure 2. Inside view of the polar telescope. The Optec photometer is attached to the telescope and the computer. Also visible are the 17-inch R.A. circle, the declination control, the sunscreen, and the gimbal which supports the instrument in the observatory wall.

than true sidereal, but the difference tends to compensate for the effects of refraction.

The entire rotating unit, consisting of tube, yoke, and flat mirror, is mounted in a box which is supported in a large gimbal or fork set into the observatory wall. Screw adjustments are provided at the lower end to facilitate motion in altitude and azimuth for collimation. In mid latitudes, where the tube is inclined at approximately 45 degrees, the observer is seated on an ordinary bar-stool in front of the console with all controls within easy reach and with the eyepiece or accessory equipment always in the same place, no matter where the telescope is directed. The heavy outer cover for the telescope is opened by pulleys which operate through the building wall, and the two smaller covers for the flat and the yoke are accessible through a hatch, all of which can be done from inside.

3. Disadvantages

The big disadvantage of all polar telescopes is the limited field of view. Unless installed in a very oddly shaped building, a large part of the sky is inevitably occulted. However, since the instrument must have a southern exposure, the entire ecliptic is always in view, with declinations at least to the zenith usually available.

Another drawback is the fact that the flat mirror is completely exposed to the weather during observing sessions. This does reduce the life of the coating. Mine has to be re-aluminized every two or three years.

A minor problem is field orientation. North is at the top, with west on the left and east on the right. The solution is to hold the AAVSO chart, with north at the top, over the console light and view it through the back. In 30 years I have become quite adept at reading digits upside-down and reversed.

4. Advantages

There is no doubt that the greatest boon of a polar-axis telescope is for winter observing. Not only the observer but all the essential components, such as drive, electrical equipment, and main bearing, are inside in the warmth. In the past I have frequently observed when the outside temperature was -25°F, while I was seated in a room at 70°F.

The second obvious benefit is an extremely stable mounting. The unit is fastened by ½-inch bolts to the wall of a 13-room brick house. It cannot move. Furthermore, one idiosyncracy of a polar telescope is that counter-balancing is completely unnecessary, no matter what accessories are added to the tube. The entire instrument is supported by massive bearings at each end. Adding more weight at one end doesn't in any way affect its stability.

Polar telescopes make ideal instruments for solar observing. The 8½ x 11 inch sunscreen is firmly mounted on a bracket at the side of the console and the sun's image directed to it by a diagonal. Since the observatory part of the building has no windows, the only light present is that of the solar image; shielding is not needed. In addition, the screen is solid enough that, with the drive running, sunspots can be traced on a sheet of paper marked with a 7-inch circle and clipped to the screen. After marking the drift of a spot to get an E-W line, the result can be placed over a Stoneyhurst disk to obtain the orientation of the solar equator and accurate spot positions. A separate bracket allows the mounting of the SLR camera, with extensions, on the console in front of the sunscreen for close-up photographs of sunspots. It is also possible to impress visitors by placing a movie screen at the other end of the room, turning off all lights and projecting on it an image of the sun 4 feet in diameter.

The mirror yoke itself has other uses. A camera, with or without telephoto lens, can be bolted to either side-arm of the yoke for piggy-back photography; and the same bolt-holes can support a Thousand Oaks solar filter in front of the objective without the slightest chance of it falling off from wind or vibration.

5. Observing programs

In the early 1960's, the Milky Way was readily visible from this location. When first put into use, the polar telescope could reach about magnitude 11.5 to 12.0, and was used primarily for visual photometry of variable stars during the winter. From spring to fall, this work was carried on in the second-story dome with the 8-inch refractor, and later with the 10-inch Schmidt-Cassegrain. The polar telescope is used for the observation of sunspots, however, during the whole year.

Light pollution gradually increased as the city of Toronto moved closer, and the population of Maple grew from about 900 in the 1950's to about 15,000 today. In the last few years the magnitude limit for the polar telescope has dwindled to about 10.0, while the 10-inch in the dome will barely reach 12.5. Therefore, in the 1980's it was decided to beat the polluted skies by taking up photoelectric photometry, since the stars in the AAVSO photoelectric photometry program are all bright.

At first there was some doubt as to whether a telescope this small would be viable for photoelectric photometry, and it was necessary to change the original (Meccano) drive into the much heavier and more accurate unit described above. But a few trial runs proved that photoelectric photometry was indeed possible, and photoelectric observations were started in the fall of 1990. While the standard error values tend to be higher for the 4¼-inch than the 10-inch, and a few observations have to be rejected each season when the value exceeds 0.02, the fact remains that the polar telescope is quite capable of producing usable photoelectric data during the winter.

From the beginning, a computer desk was installed right beside the polar telescope console and a "home-brew" data acquisition program used to control integration, timing, and the recording of data from the Optec SSP-3 photometer. In 1993, at the suggestion of Howard Landis, AAVSO Photoelectric Photometry Committee chairman, we converted from Commodore to PC-compatible and were able to use Robert Jones' excellent program ACQ (Jones 1991) as well as Howard's own CONVACQ, which converts the raw photoelectric data into a file in AAVSO format. These are sent to Howard by e-mail in sets of 10 and, after a final check and reduction, are ready to be archived.

6. Conclusion

To date, over 3000 observations have been submitted to the AAVSO photoelectric archive, of which approximately 40% have come from the polar telescope.

Thus the polar telescope, while perhaps limited in some respects, offers many opportunities for interesting and valuable observing.

Reference

Jones, R. A. 1991, *IAPPP Comm.*, No. 44, 53.