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The Prairie Astronomer

How to Support a Telescope Mirror

by Steve Dodson

(presented in it's entirety from last month)

Imagine an empty telescope tube and a fine straight line passing directly down it's centre (the tube axis). For simplicity let's assume that the optical axis of the telescope will lie along the tube axis. Now imagine a parabolic curve cutting across the tube axis near its lower end, its own axis exactly aligned with the tube axis. In your mind rotate the parabolic curve about the tube axis and you will have a perfectly aligned "ideal" paraboloidal surface.

For excellent telescope performance we want the reflecting surface of our mirror to lie precisely along this imaginary "ideal" paraboloidal surface. Any deformation of the mirror's surface away from the ideal paraboloid should be a very small fraction of a wavelength (1/8 or less) since reflection makes each error count twice. Here we are talking about precision levels amounting to a couple of millionths of an inch or so. Any tilt of the mirror's axis away from the optical axis of the telescope should be less than a tenth of a degree for long-focus mirrors and even smaller for faster systems.

Obviously mirror positioning and supporting system for a high performance reflecting telescope has to hold the mirror precisely in position without forcing it in any way that would distort its shape.

The magnitude of the problem can be visualized by seeing the mirror disc as mechanically resembling a disc cut out of a foam mattress! When bends and bumps on the order of small fractions of a wavelength of light are important glass behaves exactly like that. If you can design a support system that doesn't allow a floppy mattress disc to flop visibly out of shape you probably have a good mirror support system.

In the past a common approach has been to make the mirror so thick that it had enough rigidity to cover-up the sins of the support system. Mirrors up to 12 1/2 inches in diameter with thicknesses equal to at least 1/6th of the diameter can safely be mounted in a simple manner. But lighter mirrors have been increasingly in favour. Consider the example of the 5 meter mirror of the Hale Telescope at Mount Palomar, and the sophisticated support system that was employed to allow the glass to be lightened. If the mirror disc were solid glass 5/6 of a meter thick it would have weighed well over 30 tons, and even a simply support system would have contributed significantly to a snowballing escalation of the overall weight of the telescope and mounting.

Continuing the analysis started above a mirror support system must perform the following functions:

A) It must keep the centre of the mirror from moving off the optical axis of the telescope. RADIAL OR EDGE SUPPORT takes care of this.

B) It must keep the reflecting surface from moving up or down the tube axis. BACK SUPPORT (Also called SUSPENSION) takes care of this.

C) It must keep the reflecting surface squared-on to the optical axis. BACK SUPPORT takes care of this too.

D) It must do all the above WITHOUT creating enough unequal pressure on the mirror to distort it! (Remember the foam disc!)

When the telescope is aimed low in the sky most of the weight of the mirror will be taken up by the edge support system. If it consists of small pads or pressure points around the edge of the mirror they can distort the mirror. Star images seen at high power may have "spikes" in the corresponding directions. As the tube rotates on an equatorial mounting we want the edge supports to push upwards on the mirror balancing its weight without squeezing it sideways, which would also create distortions. This is why in equatorial telescopes many schemes have been adopted for edge support, such as air-bags, mercury-filled rubber tubes, and networks of weighted levers.

For telescopes with thin mirrors and altazimuth mountings the beautifully simple solution to the edge support problem is John Dobson's sling. A seat-belt or other strong strap hanging from two blocks at horizontally opposed positions on the mirror cell's back plate circles the lower half of the mirror and supports it exactly as required. If the strap contacts only the REAR two-thirds of the mirror's edge virtually no distortion will be produced in the thinnest glass!

When the telescope is pointed high in the sky most of the weight of the mirror will be on the back supports. To understand the BACK SUPPORT problem let's think again of the disc of mattress foam. If you set this "floppy disc" down on a heavy rigid plate, then any unevenness in either the back of the foam disc (the mirror) OR the heavy plate will be transmitted to the front (reflecting) surface. If we try supporting our floppy "mirror" on a lighter yielding back plate it may distort as much as your back does when you lie in a hammock!

So just laying a mirror down on any kind of a backing plate (using a simple flat-backed cell) is not a great

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idea, at least for a mirror that is getting on the large or the thin side.

Now suppose the foam disc is again lying in a horizontal position (like the mirror of a telescope pointing towards the zenith). Suppose you and a friend place your finger-tips under the outer portion of the back of the disc and gently lift up. Of course the foam will sag towards the middle. SO WOULD A MIRROR SUPPORTED LIKE THIS. Now imagine placing a hand under the centre of the disc and lifting it. The outer edge of the disc will sag.

Where would you place your hands to get the least sagging? The answer is you would need THREE hands evenly spaced under the 70% zone, that is 70% of the way from the centre to the edge. This works because each hand will now be supporting two equal portions of foam (or mirror) by weight -- one towards the centre and towards the edge. There is a state of balance here.

This sort of dividing the mirror up into balancing portions or domains has to be carried further and further as larger or thinner mirrors are used. The three hands at 70% constitute the familiar three-point suspension. If more points are used, each centered in smaller pairs of balancing "domains", there will be less pressure at each point and less sagging between points.

Place a TRIANGLE of the correct dimensions between each of the three points above and the mirror's back and we get a NINE POINT suspension. These triangles have contact points at their vertices and MUST rock freely on the original three points. If so the nine points will conform perfectly to the back of the mirror with perfectly even pressure, even if the back of the mirror is not flat.

Place short straight bars with support points between the mirror back and each of the nine points on the triangles and voila, the 18 point suspension! John Dobson has found this to be good enough for his 24-inch mirror, which is only one inch thick.

Of course we can get an even smoother distribution of the mirror's weight if we put tiny triangles on top of the bars..... (54 point suspension???).... but you get the idea by now!

It is of utmost importance to get all the support point positions and lever lengths (rods and triangles) just right, or else some points will bear harder on the mirror than others. The dimensions for 9 and 18 point suspensions are given in AMATEUR TELESCOPE MAKING BOOK ONE, available from Scientific American, pages 229 to 234. See also TELESCOPE MAKING MAGAZINE #26. To modify or extend these designs use the principle of equal portions of the mirror's weight. This principle means that if your mirror is proportionately a lot thinner in the middle than at the edge the support points will be spread out further from the centre of the disc. Maybe someone can write a program to calculate the support points for any number of points (3, 9, 18, 36, 54, 108...) and any centre-to-edge thickness ratio. HINT...HINT...

Notes From the 2nd V.P.

by Ron Debus

The August 13 PAC picnic was quite enjoyable and we had a great turnout. After the picnic we gathered at the observing site and there were 23 counting the kids. Viewers brought six large telescopes, two 11x80 binoculars, and several pairs of 7x50 binoculars. And yes, the night sky was as fine as it could be. Everyone seemed to have a good time running back and forth between scopes.

Sometime early in the morning (2 a.m.) the small group that stayed (7 or 8) decided to count meteors from the Perseid shower. I saw a large number of meteors that night and eventhough I had just purchased the book Thunderstones and Shooting Stars, I just couldn't pull myself away from my telescope to get in on the count. There was just too much to see. I even went back to some objects a second and third time.

As a program for our newsletter, I would like ALL members of the PAC and readers of the newsletter to write to the Prairie Astronomer editor, John Lortz, and give him a brief history of your interest in astronomy. Our editor has asked many times for articles, so let's flood his mailbox. I know I'll enjoy reading your columns and I'm sure others will also. Here's my story...

I've always liked hearing about the stars and planets, but I had never looked through a telescope until the Hyde Observatory opened. Being so fascinated by the planets and deep sky objects, I eventually purchased a telescope (a 2.4 inch refractor). I then joined the PAC, and since joining I've built a 10 inch dobsonian. I was also elected to the post of 2nd V.P. of the club, and became a volunteer at Hyde Observatory. This month's meeting will be my 45th straight meeting since December of 1984. I've not missed since that time. (Does anyone know the record for consecutive attendance at meetings???) I like to keep my astronomy interests simple, however, as each meeting, star party, and volunteer night at the observatory goes by I find my knowledge of astronomy increasing. I've often thought of trying to become a supervisor at the observatory.

Thanks for listening, and remember... programs are a big part of our club, so let's keep them going!

Observing Chairman's Report

by David Knisely

THE NEXT SCHEDULED START PARTY IS ON FRIDAY, SEPTEMBER 9TH AT THE ATLAS SITE. Wow, what a turnout we had at the last star party! I counted ten telescopes and a couple of very big binoculars plus about 25 or 30 people. Lets keep it up!

Late summer offers cooling temperatures and a nice mix of deep-sky objects for the patient observer. Start up in Sagitta with the small globular cluster, M71, located about 1.6 degrees east and 1/4 north of Delta Sagittae. It can be seen in a 60mm refractor as a small very faint fuzzy spot, while a six inch aperture resolves it partially. An eight inch will resolve it well and a ten inch makes it an interesting ball of faint stars in a rich background.

For those of you who want something a bit easier, try the open cluster M29, located about one and a half degrees south of GAmma Cygni. It is a moderate sized group of 10 to 15 fairly bright stars in small telescopes. Larger instruments do bring out the Milky Way background but otherwise add little to the view. There is actually a galaxy in Cygnus! It is NGC 6946, and can be found by looking about 1.5 degrees south and 1.5 degrees west of Eta Cephei. A six inch will show it as a moderate to small faint fuzzy patch of light that is slightly oval in shape. An eight inch aperture will show a brighter center and the patch outer haze, but it takes a larger cope to show much of the spiral structure. In a 12.5 inch, it looks a bit like M33 does in an eight inch.

Just over the border in Cepheus is the "Stadium Light Cluster", NGC 6939. Use a six inch and look about 1.25 degrees south and just under two degrees west of Eta Cephei to find this interesting group of stars set in a couple of neat rows like ball park lights.

Aquarius offers a few interesting sights including NGC 7009, the Saturn Nebula. Located about 1.3 degrees west of Nu Aquarii, this small planetary nebula looks like a fuzzy 9th magnitude star in a 60mm refractor. A six inch will make it look like a tiny bluish oval, while an eight inch will make it appear more green in color. The ansae or the points that give the object its name can be seen in a ten inch at high power. Also in Aquarius is the rich globular cluster M2, located 4.75 degrees north and a

half east of Beta Aquarii. Visible in binoculars, this object takes a six inch to show many of its stars. The view in an eight or ten inch at high power is spectacular. A much tougher object is NGC 7293, the Giant Helical Nebula, located 1.25 degrees west of Upsilon Aquarii. It is visible in 10x50 binoculars as a faint fuzzy patch, but the use of at least a six inch rich field scope is required for good viewing of this nearby planetary. The Lumicon OIII filter helps greatly, making the object stand out much better than without the filter. A ten inch with the filter begins to show the object's helical structure.

In Pegasus is the fairly bright spiral galaxy NGC 7331, located about 4.3 degrees north and one degree west of Eta Pegasi. Small telescopes show it as a very faint fuzzy oval patch of light. An eight inch makes the nuclear region stand out, as well as showing hazy outer extensions and a marked drop-off of light along the galaxy's west side. A ten inch will show the dark lane and a few patches of light in the outer haze plus a couple of faint tiny galaxies just to the west of 7331. For those of you with large instruments, you may want to look less than a degree south and a bit west of NGC 7331 for the small group of very faint galaxies known as "Stephan's Quintet". They are difficult to see due to their faintness and small size, but are well worth the effort.

At The Last Meeting

by Ellen Owen

The July 26 meeting of the Prairie Astronomy Club was called to order by President Del Motycka, who re-introduced himself and explained that his main purpose in life is to keep Lincoln free of prairie dogs.

Seven visitors from such widely divergent places as Lincoln and Africa were introduced.

Dan Neville was in France, so there was no Treasurers report.

The minutes of the previous meeting were read and approved.

Two items were discussed under old business. First the telescope making class which as been discussed before received no notes in last month's newsletter. Apparently the Great Dane struck again. Secondly, sanitary facilities for the Atlas Site are not yet completed, but Ron Veys and Dave Owen will contact each other, pre-fabricate the facility, and assemble it on the site. It will be made of minimal material, and Dave Knisely suggested painting our own slogans on it to prevent vandalism. Del suggested inviting the Superintendent and Principal of the Norris school, students and faculty of the school, neighboring property owners, and COOP board members to involve the Firth area community and also possible prevent vandalism. It was suggested that we begin with limited numbers of Norris students, such as science classes.

Dave Knisely reported the club telescope nearer to completion. He is working on acquiring a secondary mirror from a 'fixed-up' Jagers.

The invitation to Norris school, especially the staff and science class, and to the COOP board members and property owners was further discussed. Russ Copple moved to invite these people in September or October. The motion carried.

Insurance for the site was discussed. Del explained that it is liability insurance only. Also, he wanted to know if any club member knew for sure how or if the company was satisfied with the precautions we have taken at the site.

House Boat
Around the World 80 days

Welcome New PAC Members!

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Debra Cohn
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Next PAC Meeting
August 30th, 1988