REFLECTIONS AND REFRACTIONS

OF THE UNIVERSITY LOWBROW ASTRONOMERS

March 2004

Upcoming Events

March 2004

- **Friday, March 19, Starting at 7:30. Monthly Club Meeting held tentatively in room 170 in the Dennison Building.**
- **Saturday, March 20, (Starting at Sunset) Regular Scheduled Open House and Star Party at the Peach Mt. Observatory. Weather permitting.**
- **Saturday, March 27, 10:30 a.m. Saturday Morning Physics. "Black Holes in String Theory," presented by Professor Leopold Pando Zayas.**
- **Saturday, April 3, 10:30 a.m. Saturday Morning Physics. "Dark Energy and our Runaway Universe," presented by Professor Gregory Tarle.**
- **Saturday, April 10, (Starting at Sunset) Regular Scheduled Open House and Star Party at the Peach Mt. Observatory. Weather permitting.**
- **Friday, April 16., Starting at 7:30 p.m. Monthly Club Meeting, held in room 170 of the Dennison Building.**

Doug's Deep Sky Challenge

by Doug Scobel

Hickson 44 - Galaxy cluster in Leo

With spring fast approaching (it may actually be here by the time you read this), the thoughts of many deep sky aficionados turn to – you guessed it – galaxies! And the constellation Leo the Lion leads the charge, with Virgo, Coma Berenices, Canes Venatici, and Ursa Major sure to follow. But let's take a closer look at Leo first. Now Leo contains some well-known galaxy groups, such as the bright pair Messiers 95 and 96, and the trio M65, M66, and NGC 3628, also known as the Leo Triplet. But there is another nice grouping of galaxies in Leo, which, while not as bright, is even easier to find, and presents up to four galaxies in the same low to medium power field!

This little group, also known as "Hickson 44", is believed to be about 50 to 60 million light years away. It consists of the four members NGC 3185, NGC 3187, NGC 3190, and NGC 3193, and lies almost exactly halfway between second magnitude gamma Leonis ("Algeiba") and third magnitude zeta Leonis ("Adhafera"). These are the second and third stars in Leo's "sickle", as counted from Leo's brightest star Regulus. This fortunate placement makes the group a sure find – just aim your scope right in the middle between those two stars, and you should be right there.

So, what should you expect to see? Three of the galaxies, NGCs 3193, 3190, and 3185, are arranged in a more or less straight line running roughly northeast to southwest, spanning a total distance of about 20 arc minutes. NGC 3193 is at the northeast end, followed by 3190 about five arc minutes away, and finally 3185 after another fifteen arc minutes or so. The fourth galaxy, NGC 3187, lies about five arc minutes northwest of 3190. All four easily fit inside the same medium power (about 100x – 150x) field, and make for a very nice view.

NGC 3193 is the brightest of the four, being listed in The Deep Sky Field Guide to Uranometria 2000 with a total visual magnitude of 10.9. But in my 13", it doesn't look as bright as nearby NGC 3190, which shines a little less brightly at visual magnitude 11.2. NGC 3193 measures 2.5 by 2.5 arc minutes, but it looks a little flattened to me. It is listed as an elliptical galaxy, which explains the very gradual brightening towards its center. There is an approximately 10^{th} magnitude foreground star just touching its northern border.

NGC 3190 is listed as a peculiar spiral, extending 4.1 by 1.6 arc minutes. It has a very elongated appearance, with a very bright core. Again, despite having an integrated magnitude that is less than that of NGC 3193, it has a higher surface brightness and looks brighter. I've found that edge-on galaxies typically look brighter to me than those that present more of a face-on profile, and these two companions are no exception.

Glowing at visual magnitude 12.2, NGC 3185 is a little more difficult to detect. But with dimensions of 1.8 by 1.1 arc minutes, its surface brightness is still respectable at 12.8 magnitudes per arc minute. It appears quite elongated with a somewhat brighter nucleus, while being noticeably smaller and fainter than its two brighter neighbors.

By far, NGC 3187 is the most challenging galaxy in this group to spot. It's listed at only magnitude 13.4, with dimensions of 3.2 by 1.4 arc minutes. This makes its surface brightness only 14.9 magnitudes per square arc minute. You'll need a steady, transparent night under dark skies, good optics, and a fairly large aperture to detect this baby! In my 13" at Lake Hudson State Recreation Area, it was a faint, elongated smudge, visible only with averted vision.

So, while this group's members are not all that bright, it is still one of my favorites, largely because it is so easy to locate, and also because it's a challenge to see all its members. Perhaps the next time you are looking at some of the better known galaxies in Leo, you might want to take a little well-marked detour and check these out for yourself. I'd like to know - what do *you* see?

Genetic Competition

By Tom Ryan

I was having a discussion with the mechanical engineers at one of the companies I occasionally work for, and they wanted to know about Zemax. I had been brought in as an optical engineer to solve a couple of their product's more puzzling problems, and they were frankly irritated that management had given me *carte blanc* to change their mechanical designs in any way I chose, and became even more unhappy when the changes worked. It couldn't be me, they reasoned. After all, I'm old, short, and my memory isn't so good, which probably reflects the condition of my brain in general. It must be the optical design software I was using, and they wanted to know about it, so they could wield the power of the Ring.

I explained that Zemax was a little like the Autocad program they were using, in that it could make drawings of lens systems, and trace light rays through the resulting system to see where they ended up. They already knew that, since they had been instructed to match the positions of the lens mounts in Autocad to the positions that Zemax dictated. They had seen Zemax's drawings, and they felt that they were pretty crude. One of the guys showed me that he had an add-on program to Autocad that traced rays, and it looked a whole lot better on the screen than the output of Zemax, so what was so special about Zemax?

Now, these guys were using Autocad, which is still a very popular program. Autocad produces absolutely beautiful blueprints, but it had its finest hour sometime in the 1980's. Mechanical CAD programs have moved on in many ways. Ways which are mysterious to most Autocad fans. One of these ways is automatic design optimization, and Zemax has got it, and Autocad doesn't.

Automatic design optimization is what takes place when a design engineer draws a giant hunk of cast iron between the alternator and the engine block, and tells the program to change it's dimensions and material type to produce the lightest possible bracket that will keep the alternator attached to the engine until the warranty period is over. Pro/Mechanica does this, and so do a couple of other mechanical design programs. Zemax does this with lenses. I told the guys that Zemax could start an optical design with a bunch of parallel plates instead of lenses, and it would produce an excellent optical design, sometimes the best one possible, at the press of its "Optimize" button.

Their suspicions were immediately confirmed. "If Zemax will do that, then what the hell do we need *you* for?".

A good question. When people spend a lifetime listening to just one news source (Autocad is best!) they can appear naive when they get into the wide, wide world, and giving advice to the willfully naive is an impulse that I try to resist. There's no percentage in it. People who need advice usually won't take it, and people who will take advice usually don't need it.

There is, however, something to be gained by keeping your customers happy. I told them that Zemax occasionally produces designs which are impossible to build. Lenses with negative thicknesses, spaces between lenses where the light goes backwards, and other impossibilities. Oh, they said.

The truth is a little more complicated. Zemax has two methods of optimizing a design, which it calls Local and Global. In both cases, Zemax is trying to minimize a value that the lens designer constructs out of the desired performance of the system. You could call it a merit function, or performance, or attractiveness, but in all cases, it is a function of the parts of the optical system that Zemax is allowed to change. It may be constructed out of the size of the focused spot that the system forms at certain field angles and wavelengths, or the angle that the rays strike the focal plane, or anything else that you want to control. Whatever it is, Zemax changes the lens spacings, radii, and other things to make this value as small as possible.

The Local optimization routine is based on damped least squares, which means that Zemax looks at the optical system that the designer provided, computes the merit function, calculates the derivative of the merit function with respect to all of the variables that it can change, and moves the system "downslope" in variable space. It's like what you would do if you were blindfolded on a hill, and were asked to find the lowest point possible. You'd feel around in all directions, and then take a step in the steepest down direction.

This method works very well in finding a local minimum. Optical space is vast, however, and usually looks more like West Virginia than Meteor Crater. A local minimum may not be a very good solution, but the optimization routine can't climb up over a hill to find a lower valley on the other side.

Why, you ask, can't Zemax, or any other optimization program, just calculate the merit function for all possible solutions, up hill and down? The answer involves the meaning of the word Never. J. Jeans said that "six monkeys, set to strum unintelligently on typewriters for millions of millions of years, would be bound in time to write all of the books in the British Museum." Though it sounds good in a public lecture, Jeans' failure to actually do the math on this type of problem would lead him to buy lottery tickets today. The truth is that the probability that 10^10 monkeys, seated at typewriters throughout the age of the universe, each hitting 10 keys per second, would type out even one single book (Hamlet, for example, at 10^5 characters), is 10^(-164,316). That means Never.

Thoroughly evaluating the solution space of a very simple lens system with just 12 different variables (three lenses having six surfaces, three glass thicknesses and three air gaps) would take about 300 billion years on a fast computer. This illustrates what I think of as the failure of the deterministic method.

I might add at this point that Zemax will only produce impossible solutions if the designer has done an incomplete job of setting limits on how far Zemax is allowed to change variables. When exploring the initial stages of a design, though, it's often just not worthwhile to type in all the possible limits.

To get over a local hill, Zemax must switch gears to its Global optimization routine. Its Global optimization routine is based on Genetic Algorithms which, in turn, are modeled on life itself. Genetic algorithms model the variables of a system as bits of an imaginary creature's genetic code, and they evaluate the creature's code in terms of its suitability for survival. A number of creatures are created, perhaps 100, and creatures whose suitability for survival is high are bred with one another to form new creatures. The least suitable are eliminated, and the population is tested again. Sometimes random mutations are inserted into the population. A superior creature can last many generations before it is out-competed by its offspring.

To give you some idea of how this really works, lets say that a variable, such as the conic constant of a mirror (which determines whether it is a sphere, parabola, hyperbola, or something else entirely) is allowed to take on values within a certain range. In a simple four bit (not 32-bit) computer, one end of the range is assigned the value of 0000, and the other end the value of 1111. Perhaps one particular creature's conic constant is randomly assigned the value 1010. All of the other variables (like radius and thicknesses) are also assigned ranges and values, and all of the resulting four-bit numbers are strung together to make one large number. That number is the creature's genetic code. Every creature's code is then examined for its suitability to survive. In a simple case, that might just mean asking whether the creature brings the light closer to a focus or not. Creatures whose genetic code happens to focus light better than others are more suitable to survive. The best perhaps half of the population are chosen to reproduce. Reproduction is carried out by randomly selecting bits from one parent's code (say 10XX) and taking the remaining bits from another parent (XX11) to produce the offspring's code (1011). The population has now grown by the number of offspring, and in the interests of keeping the calculations to a manageable number, an equal number of least suitable codes is eliminated from the pool.

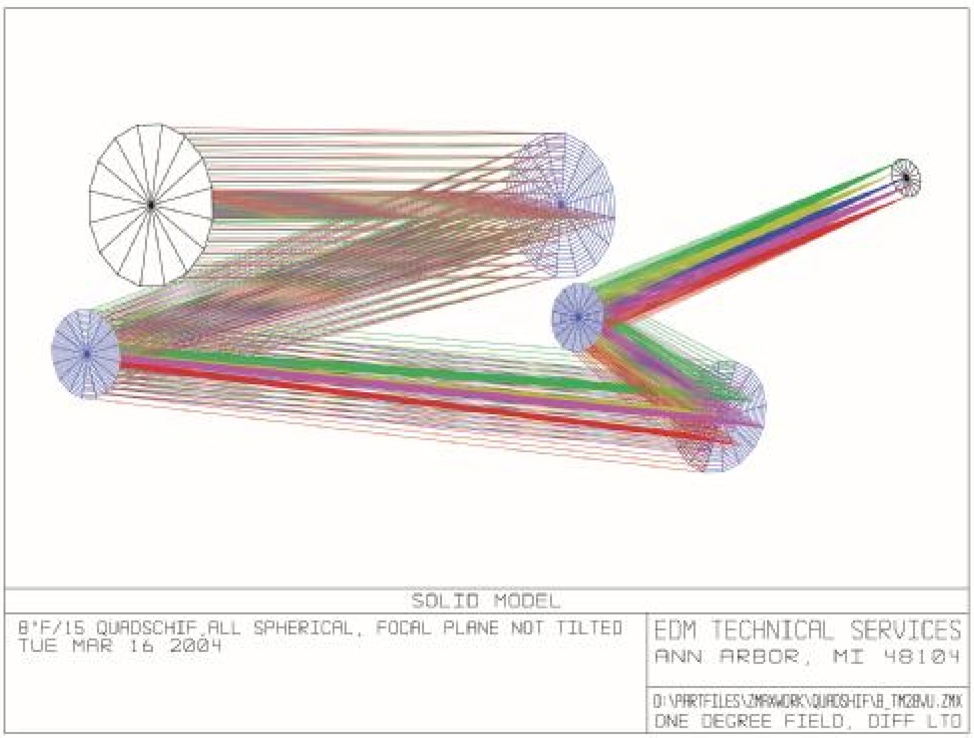
Since the initial population has the components of its genetic code chosen completely at random, the variables can be said to range across all of the hills and valleys that the lens designer permits, when he or she initially sets the ranges of the variables. The global search space can be as large as the designer wishes. The designer is also responsible for deciding which traits are selected, when he creates the merit function.

How well does this work, you ask? When the problem of a three lens system with 12 variables was analyzed by the Genetic Algorithm optimization routine, starting from parallel plates, the routine found a *very good* solution in six seconds. It found a *slightly* better solution in four hours. Did it find the global best solution? There is no way to know, unless you are willing to wait 300 billion years.

The speed with which this method produces a very good solution should be a wake up call to creationists. The likelihood of a pile of mud self-assembling into a human, a tree, or a butterfly is much worse than 10^(-164,316), but the likelihood of any ***adaptable, self-reproducing, unlimited process***, starting from a small population of interacting simple hydrocarbons, eventually taking over the universe, is very close to 1.

So, the real reason that the above-mentioned company might need me is to set reasonable limits on where to look for solutions, and to decide what constitutes a good solution when one is found. This process is not foolproof, though, and I will admit, I make mistakes from time to time.

Two examples of Genetic Competition-driven design.



About the University Lowbrow Astronomers

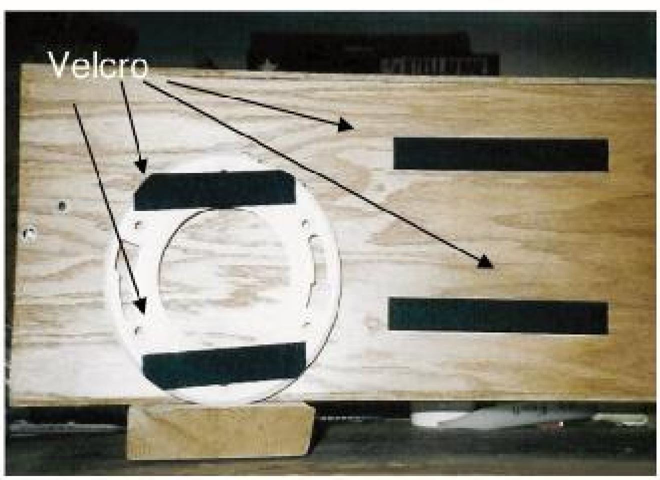
The University Lowbrow Astronomers is a club of Astronomy enthusiasts which meets on the third Friday of each month in the University of Michigan's Physics and Astronomy building (Dennison Hall, Room 130 or 807). Meetings begin at 7:30 PM and are open to the public. Public star parties are held twice a month at the University's Peach Mountain Observatory on North Territorial Road (1.1 miles west of Dexter-Pinckney Road; further directions at the end of the newsletter) on Saturdays before and after the new Moon. The party may be canceled if it's cloudy or very cold at sunset. For further information call (734) 480-4514.

The Multifunctional, Reprogrammable Velcromatic Side Bearings with ***Magic Slider***

By Jack Brisbin

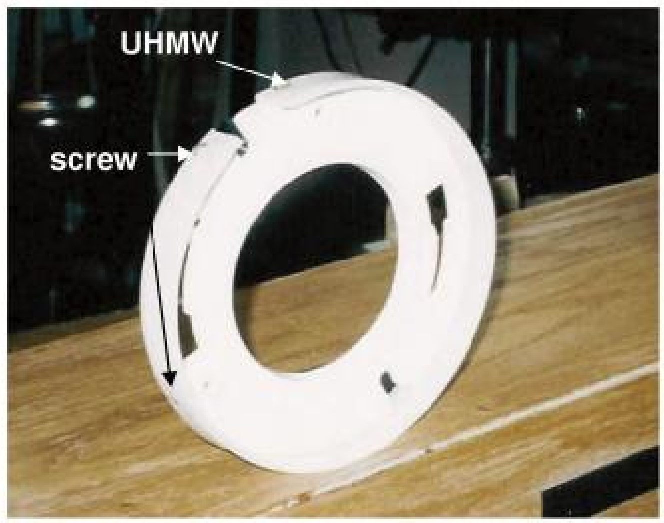
While contemplating on building a telescope of my own design, I decided to use existing optics from other telescopes and stuff from the ATM vault of stuff I forgot I had. I wanted to be able to use various finder scopes, eyepieces and secondary mirrors on this particular telescope. This also means you need some type of adjustable (re-programmable) side bearing to compensate for the different changes in weight to balance the telescope and make it more multifunctional.

I have often thought about using Velcro to hold the side bearings (altitude) to the telescope tube and eliminate the cradle and/or sliding weight to balance the tube. By using two strips of Velcro you could reposition the side bearing on the tube and compensate for the weight (balance point) of the telescope. The telescope tube pictured is a square wood tube that is 36' long and holds an 8" f4.5 mirror.



As you can see from the above picture, two self sticking Velcro strips each 7 inches long are attached to both sides of the square telescope tube. Two more strips are attached to the back of the side bearings which is a 4" PVC closet flange extender that cost $2.68 each. The Velcro is black, industrial strength and used in the auto industry. Lowes and Home Depot sell a similar type that is two inches wide. Do not use the ¾" white. It does not have the same strength as the two inch.

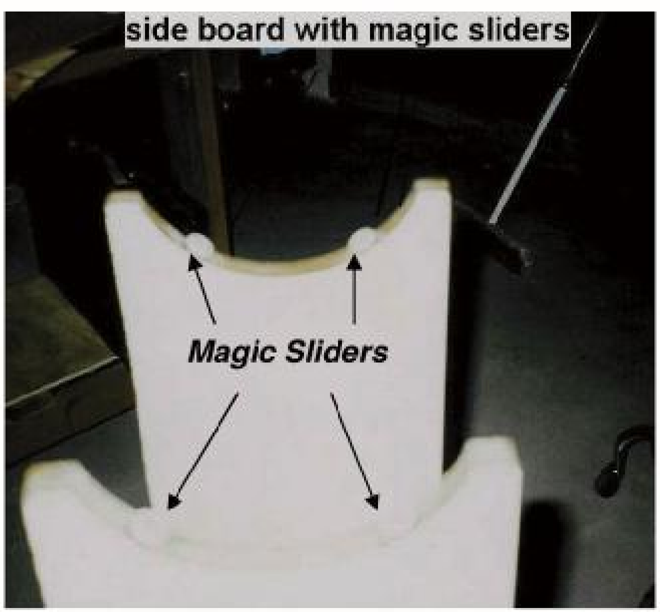
The closet flange extender is only 7/16" thick. To make it fit better with the ¾ " thick side board that it sits in. I wrapped some 1/8" thick by 1 inch wide Ultra High Molecular Weight Polythene (UHMW) around the closet flange. This increased the closet flange to 1" thick and the diameter to 7 1/4".



This photo shows the UHMW screwed to the closet flange to make a complete side bearing. I have not found any readily available glue that will hold UHMW plastic to PVC and create a strong bond. There maybe some type of industrial glue available I just don't where it is sold. The screws toward the bottom of the bearing are countersunk so they do not rub against the ***magic sliders***.

Do not confuse Magic Sliders with EZ GLIDE. The EZ GLIDE product is a dense fiber pad used as a floor protector on the bottom of chairs and tables legs. But in the ATM world they are used in large mirror cell flotation support systems, such as 9 to 27 point. They are used on the corners of the flotation triangles to support the primary mirror. I am not discussing large mirror cell systems; however, it is easy to confuse the two products.

The telescopes side bearings ride on top of the magic sliders that are mounted on top of the cut out in the sideboard of the dobsonian mount. The magic sliders have a hole in the center so you can screw them in place.
Spacing the sliders is another issue. Spacing the sliders farther apart increases the force needed to move the telescope. Moving the sliders closer together reduces the force needed to move the telescope. I have mine spaced about 90 degrees apart. The patented coated disks are gray and have a hard slippery surface.



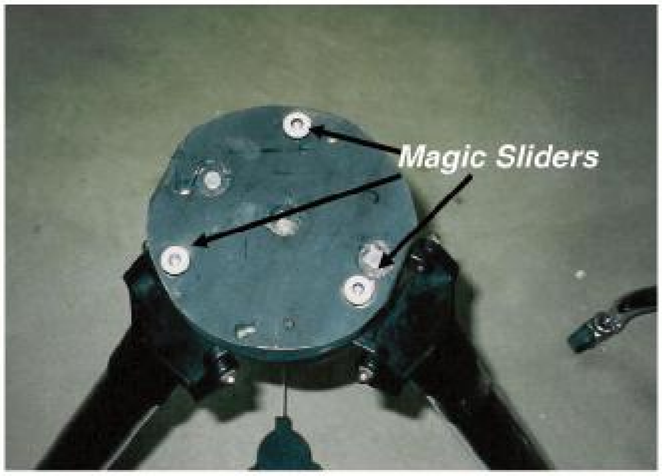
I am sure some Lowbrows reading this have these on the bottom of chairs or table legs at home.

I have been to their website, www. Magic sliders.com and they do not discuss what the magic sliders are coated with or how they are manufactured. But I suspect it is some type of liquid Teflon based material. They come with their own screws and cost $6.98 for a package of eight, 20 mm disks. This combination of UHMW and magic sliders creates a very smooth feel that is comparable to the Teflon and ebony star Formica combination.

This combination has a very low coefficient of friction that requires very little force to overcome ***static*** frictional force.

In the October 2003 issue of Sky& telescope magazine there is a very good article titled; *Better Dobsonian Bearings*, by Martin Lewis. It describes the different materials he tested, the test procedures he used and how the movement of the telescope is affected. One interesting technique was developing motion diagrams for the different combinations of materials he used. This article is a little tricky in understanding. But it is thought provoking.

The picture below shows a Meade tripod mount. I cut out a round piece of wood and bolted it to the base of the tripod mount.



The magic sliders where spaced about 120 degrees apart and screwed into the wooden mount board. The ground board that is attached to the two sideboards was placed on top of the magic sliders and secured with a 3/8"bolt. A hole was drilled in the center of the ground board, so the bolt can pass through the ground board and screw into a 3/8" T-nut that is embedded in the wooden mount board on the tripod. This allows the dobsonian mount to rotate on the magic sliders without any wobble

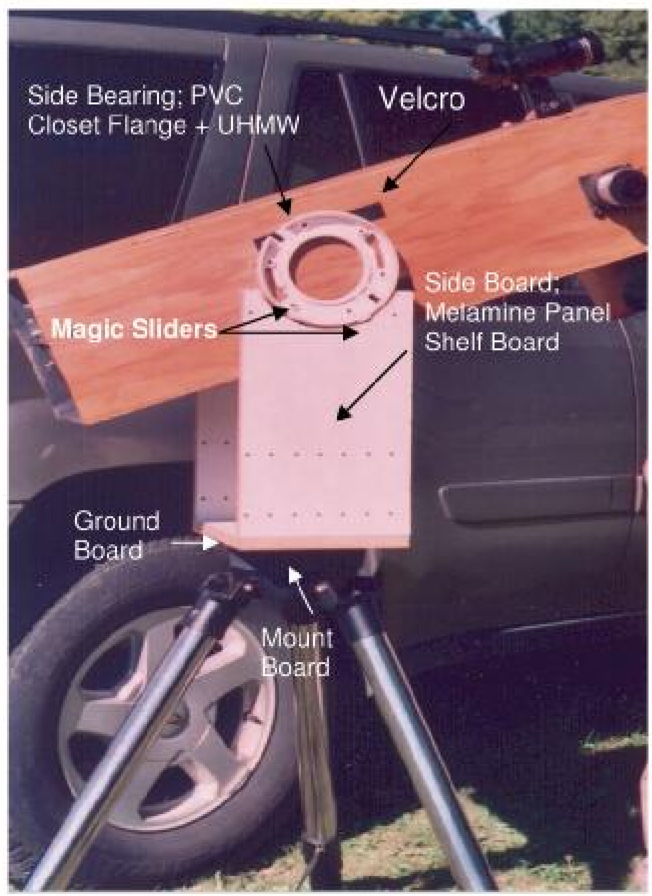
The sideboards and the ground board are made from Thermo Fused Melamine shelf panels that have holes in them for shelf pins. Both sides have a hard laminate surface that has a fine-bubbled texture similar to ebony star Formica. These were left over parts sitting next to the ATM vault of stuff I forgot I had.

This makes for a very smooth azimuth bearing that requires little force to overcome static friction. The combination of Melamine panels and magic sliders can be used for larger telescopes. The magic sliders come in larger sizes as well as the Melamine panels.

I have read and talked to people that have waxed their ground board that sits on the Teflon pads for the azimuth bearing. I tried this on the bottom of my Melamine panel ground board that sits on the magic sliders, using Turtle Wax. I could feel that it took less force to overcome the static friction to move the mount. Depending on the size, weight and type of materials you use, this may or may not be significant in rotating the mount in the azimuth motion. You could probably use other types of silicon lubricants as well as dry lubricants.

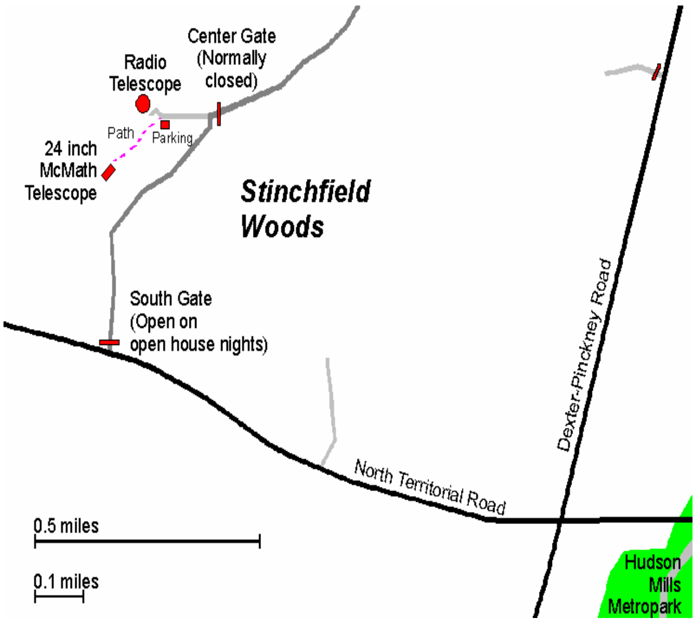
There are many different ways to build a altitude/azimuth mount as well as materials available. It is called creativity and that is one of the neat things about Amateur Telescope Makers.

To any Lowbrows that are planning on building a dobsonian mount, I still have about 50 feet of the 1/8" by 1" UHMW material left. If you are interested, I will give you enough to cover your side bearings. Years ago I sold this stuff at Astrofest and it works well. Of course the most important part about this offer is, ***I know where all the stuffs at.***



Places and Times

Dennison Hall, also known as The University of Michigan's Physics and Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. It is found in Ann Arbor on Church Street about one block north of South University Avenue. The meeting is held in room 130. Monthly meetings of the Lowbrows are held on the 3rd Friday of each month at 7:30 PM. During the summer months, and when weather permits, a club observing session at Peach Mountain will follow the meeting.



Peach Mountain Observatory is the home of The University of Michigan's 25 meter radio telescope as well as the University's McMath 24 inch telescope which is maintained by the Lowbrows. The observatory is located northwest of Dexter. The entrance is on North Territorial Road, 1.1 miles west of Dexter-Pinckney Road. A small maize-and-blue sign marks the gate. Follow the gravel road one mile to a parking area near the radio telescopes. Walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.

Public Star Parties

Public Open House/Star Parties are held on the Saturday before and after each new Moon at the Peach Mountain Observatory. Star Parties are canceled if the sky is cloudy at sunset or the temperature is below 10 degrees F. Call 4332-9132 for a recorded message on the afternoon of a scheduled Star Party to check on the status. Many members bring their telescopes and visitors are welcome to do likewise. Peach Mountain is home to millions of hungry mosquitoes - bring insect repellent, and it does get cold at night so dress warmly !

Amateur Telescope Making Group meets monthly, with the location rotating among member's houses. See the calendar on the front cover page for the time and location of next meeting.

Membership

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, and $12 per year for students and seniors (age 55/+). This entitles you to the monthly REFLECTIONS newsletter and the use of the 24" McMath telescope (after some training).

Dues can be paid at the monthly meeting or by mail to this address:

Mike Garrahan
7676 Grand Street
Dexter, MI 48130

Magazines

Members of the University Lowbrow Astronomers can get a discount on these magazine subscriptions:

Sky and Telescope: $29.95 / year
Astronomy: $29.00 / year

For more information contact the club Treasurer. Members renewing subscriptions are reminded to send your renewal notice along with your check when applying through the club Treasurer. Make the check payable to "University Lowbrow Astronomers".

Newsletter Contributions

Members and (non-members) are encouraged to write about any astronomy related topic of interest. Call or Email to Newsletter Editor at: John Ryan (734) 662-4188 allegheny@mac.com to discuss length and format. Announcements and articles are due by the first Friday of each month.

Telephone Numbers

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	Bernard Friberg	(734) 761-1875
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Observatory Director:	Mike Radwick	(734) 453-3066
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	Charlie Nielsen	(734) 747-6585
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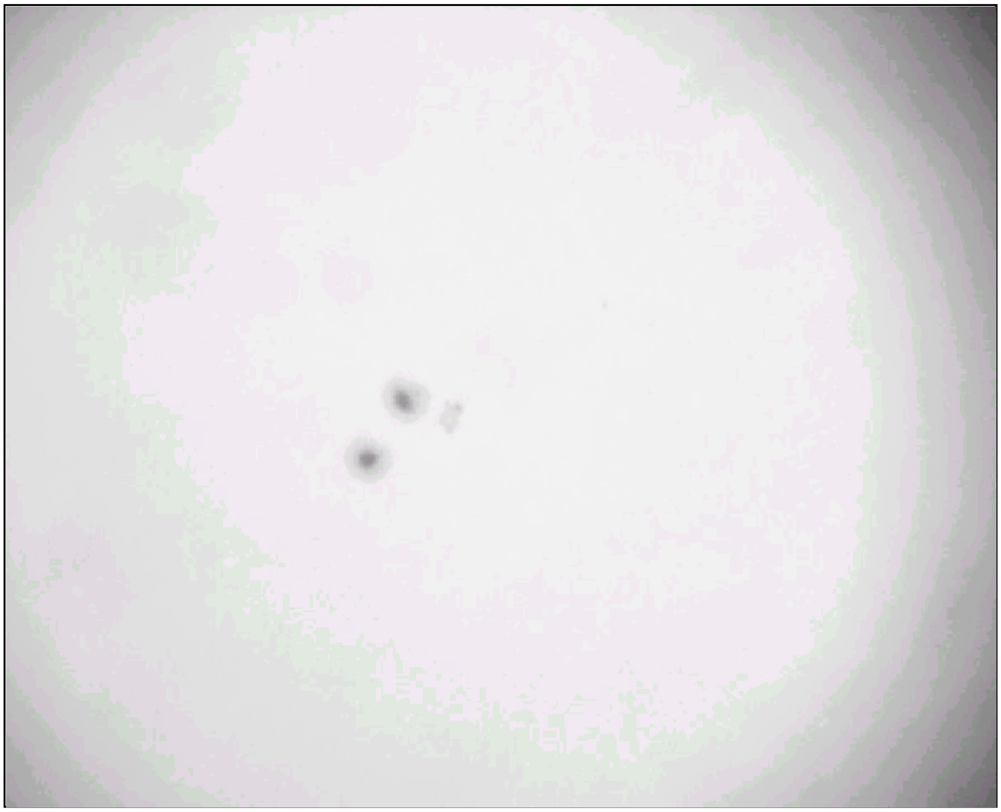
	Fred Schebor	(734) 426-2363
Webmaster	Dave Snyder	(734) 747-6537

Lowbrow's Home Page

http://www.umich.edu/~lowbrows/



Sunspots. Photograph by Gary Perrine, taken with his most excellent Coronado filter.

UNIVERSITY LOWBROW
ASTRONOMERS
7676 Grand Street

Check your membership expiration date on the mailing label.