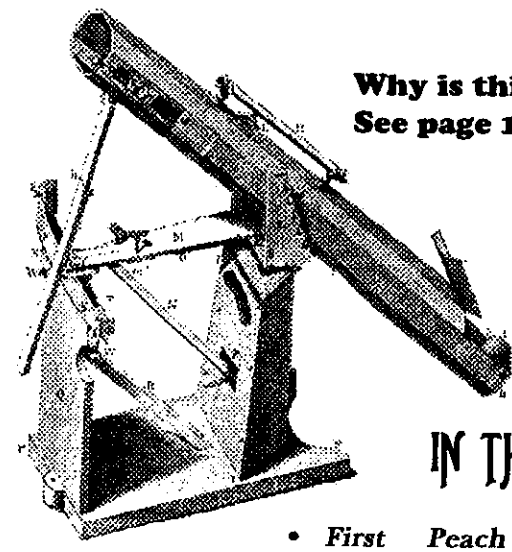
the focal point

Monthly Notices of the Atlanta Astronomy Club, Inc.

Vol. VI No. 4 December, 1993



Why is this telescope famous?
See page 14

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NEXT MEETING – DECEMBER 10

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the focal point

Monthly Notices of the Atlanta Astronomy Club, Inc.

FROM:

Leonard B. Abbey, Editor
1002 Citadel Drive
Atlanta, Georgia 30324

The Atlanta Astronomy Club Inc., the South's largest and oldest astronomical society, meets at 8:00 p.m. on the third Friday of each month at Agnes Scott College's Bradley Observatory. Occasional meetings are held at other locations (check the hot line for details). Membership is open to all. Annual dues are $20 ($10 for students). Discounted subscriptions to *Astronomy* ($18), and *Sky & Telescope* ($20) magazines are available. Send dues to: **Clay McHann, Treasurer, 3450 Jones Mill Rd., #708, Norcross, Ga. 30092**

Hot Line: Timely information on the night sky and astronomy in the Atlanta area is available on a twenty-four hour basis on the Atlanta Astronomy Club hot line: 621-2661.

BBS: The Atlanta Astronomy Club operates a computer bulletin board at 455-3089. The BBS, which is free and open to the public, provides contact with both amateur and professional astronomers around the world.

First Class

9310

W. Tom Buchanan
105 Carriage Station Circle
Roswell, GA 30075

THE 1994 PEACH STATE STAR GAZE

Join fellow AAC members, amateur, and professional astronomers from across the southeastern United States April 7 - 10 for the 1994 Peach State Star Gaze under the dark skies of the Future Farmers of America (FFA) campground near Covington, Georgia. View through large and small telescopes, share observing and astrophotography techniques, participate in talks given by amateurs and professionals, buy and sell astronomical gadgets at swap tables and much more.

Only an hour's drive east of Atlanta, the camp offers comfortable, motel-style and dormitory-style lodging, and the darkest skies in northern Georgia. All meals are cooked and provided on site. The timing is right with steady dark skies -- the humid weather and boiling skies of summer yet to come.

Programs/Features

- Observing on a flat, open field with low hoirizons.
- Talks and presentations that focus on amateur astronomy.
- Swap-tables with a variety of doodads.
- Doorprizes donated by some of America's top astronomical equipment suppliers and manufacturers.
- Astrophotography contest for the brave.
- Coffee and snacks each night.
- Electric power on the observing field.

Featured Speakers

- Michael Covington, author of *Astrophotography for the Amateur*, will talk on "Choosing the Right Film for Astrophotography."
- Jim Rouse, noted astrophotographer who presented a tongue-in-cheek talk at the 1992 FFA event on "How to Build a $500 Backyard Observatory for Under $3,000."
- Doug Gegen, astronomer at Greenville, South Carolina's Roper Mountain Observatory.
- Atlanta's own Fernbank Science Center astronomers.
- You! If you have a program, contact us as soon as possible with details and equipment requirements.

Lodging and Meals

The FFA campground is situated on 400 acres of rolling hills, woodlands and open fields with a mountainous atmosphere approximately an hour's drive east of Atlanta. The camp consists of both motel- and dormitory-style cabins. All include heat and large attic fans.

In addition, three meals per day will be served; bed linens/pillows and towels are also provided, depending on your choice of lodging. The observing field is atop a flat hill and features a wide, low horizon for your telescopic enjoyment.

A tour of the facilities is being planned by Ken Poshedly for the near future. Contact Ken Poshedly (404-979-9842) for details.

WHAT'S UP

	SUN				MOON				
Date	Rise	Azi	Set	Azi	Rise	Azi	Set	Azi	Age
12/15/93	7:35	117.7	17:30	242.1	9:23	111.7	20:09	250.0	2.9
12/16/93	7:36	117.8	17:31	242.1	10:04	107.5	21:10	254.7	3.9
12/17/93	7:36	117.8	17:31	242.1	10:40	102.6	22:09	259.9	4.9
12/18/93	7:37	117.9	17:31	242.0	11:12	97.2	23:06	265.4	5.8
12/19/93	7:37	117.9	17:32	242.0	11:43	91.9	-----	-----	6.7
12/20/93	7:38	117.9	17:32	242.0	12:12	86.4	0:01	271.0	7.6
12/21/93	7:39	117.9	17:33	242.0	12:42	81.3	0:55	276.2	8.5
12/22/93	7:39	117.9	17:33	242.0	13:13	76.3	1:49	281.4	9.4
12/23/93	7:40	117.9	17:34	242.0	13:47	72.1	2:44	286.1	10.3
12/24/93	7:40	117.9	17:34	242.0	14:23	68.3	3:39	290.1	11.2
12/25/93	7:40	117.9	17:35	242.1	15:05	65.6	4:34	293.3	12.1
12/26/93	7:41	117.8	17:36	242.1	15:51	64.1	5:29	295.5	13.1
12/27/93	7:41	117.8	17:36	242.2	16:43	63.9	6:23	296.2	14.0
12/28/93	7:41	117.7	17:37	242.2	17:40	65.3	7:14	295.5	15.0
12/29/93	7:42	117.6	17:38	242.3	18:41	68.2	8:02	293.2	16.0
12/30/93	7:42	117.6	17:38	242.4	19:45	72.4	8:45	289.6	17.0
12/31/93	7:42	117.5	17:39	242.5	20:49	77.7	9:26	284.8	18.1
1/1/94	7:43	117.4	17:40	242.6	21:54	83.7	10:03	279.1	19.1
1/2/94	7:43	117.3	17:41	242.7	22:58	90.1	10:39	273.0	20.2
1/3/94	7:43	117.1	17:41	242.8	-----	-----	11:14	266.6	21.3
1/4/94	7:43	117.0	17:42	242.9	0:04	96.7	11:51	260.6	22.4
1/5/94	7:43	116.9	17:43	243.1	1:09	102.7	12:29	254.8	23.4
1/6/94	7:43	116.7	17:44	243.2	2:15	108.0	13:12	249.9	24.5
1/7/94	7:43	116.6	17:45	243.4	3:22	112.3	13:59	246.4	25.6
1/8/94	7:43	116.4	17:45	243.6	4:27	115.1	14:51	244.2	26.7
1/9/94	7:43	116.2	17:46	243.7	5:28	116.2	15:48	243.8	27.7
1/10/94	7:43	116.1	17:47	243.9	6:24	115.6	16:49	245.2	28.8
1/11/94	7:43	115.9	17:48	244.1	7:14	113.2	17:52	248.1	0.2
1/12/94	7:43	115.7	17:49	244.3	7:57	109.7	18:54	252.3	1.2
1/13/94	7:43	115.5	17:50	244.5	8:36	105.1	19:54	257.2	2.2
1/14/94	7:43	115.2	17:51	244.8	9:10	99.8	20:52	262.7	3.2
1/15/94	7:42	115.0	17:52	245.0	9:42	94.5	21:49	268.3	4.1

OFFICERS AND OTHER DIGNITARIES

President:	Steve Gilbreath	409-1915
First Vice-President: (Program)	Hal Crawford	242-9995
Second Vice-President: (Observing)	Alex Langoussis	429-8384
Recording Secretary:	Terry McHann	441-9097
Corresponding Secretary:	Leonard Abbey	634-1222
Treasurer:	Clay McHann	441-9097
BBS:	Doug Chesser	457-5743
Edibles:	Terry McHann	441-9097
Facilities	Leonard Abbey	634-1222
Light Pollution:	Tom Buchanan	587-0774
Membership:	Terry McHann	441-9097

DECEMBER MEETING

Where: **Fernbank Science Center Planetarium**
When: **Friday, December 10 at 8:00 p.m.**
Program: **The December show, "Christmas Around The World"**

Please note that this is the **SECOND** Friday in December, not the third.

From time to time the club is invited to Fernbank Science Center to see a special presentation. This meeting will feature the current Christmas show. For our club, the usual admission fee will be waived.

Members are advised to be there early. The doors close promptly at 8:00 p.m., and no amount of wheedling will induce them to admit latecomers.

As most members know, Fernbank is one of the country's largest planetariums, and features the large Zeiss projector. After the show, we will adjourn to a classroom for the business meeting and refreshments.

These shows are always very popular, so you will not want to miss this one!

THE SWAP SHOP

FOR SALE: Tasco 4½" Newtonian with many eyepieces and accessories.

Eugene Powell 872-0891

COMING ATTRACTIONS

In the near future, we look forward to hearing Dr. Doug Gies, of Georgia State University's Department of Physics and Astronomy. We hope to hear him discuss pulsating variables, a current field of interest.

Doug Chesser will demonstrate our club Electronic Bulletin Board (BBS) system, and will distribute free software for accessing it.

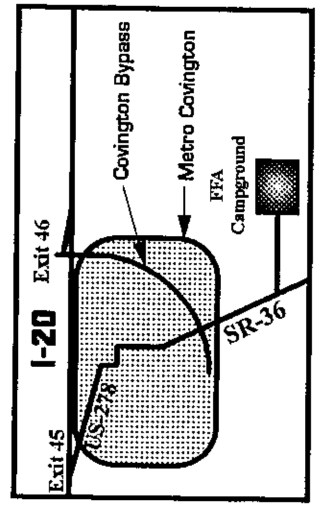
Later in the year, Dr. Hal McAlister, director of the Center for High Resolution Astronomy (CHARA) at Georgia State University will speak.

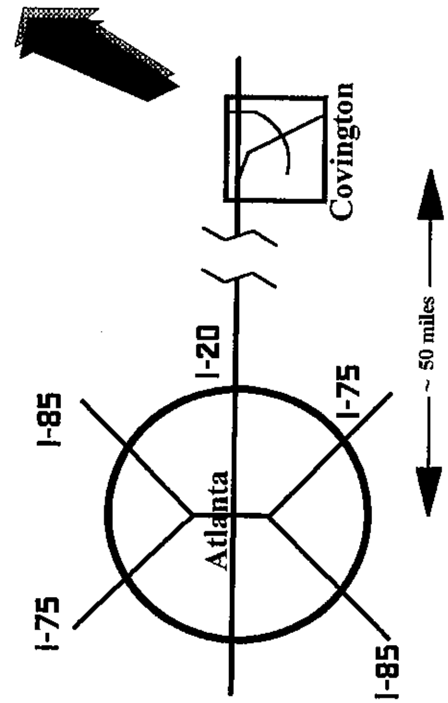
We also hope to have Dr. Tom Van Flandern, a cosmologist who is noted for his new, and highly original, insights into the origin of the universe. We will have to catch Tom on his way through town, so this meeting may not be held on the usual third Friday. Watch the *Focal Point* for details.

PEACH STATE STAR GAZE - 1994

April 7 - 10 1994

1. EAST from Atlanta on I-20, past Conyers.
2. Take Exit 45 (US 278), then turn RIGHT at 3rd traffic signal onto Emory St. (SR 81).
3. Turn LEFT at next traffic signal onto Clark St., then bear RIGHT onto SR 36W (Monticello St.).
4. Proceed approximately 13 miles to FFA camp on LEFT side of road.
5. Follow PSSG signs to registration area for lodging assignment and any additional information.





The Atlanta Astronomy Club, Inc.
Georgia's Oldest and Largest Astronomical Organization

Star Gaze Chairman:
Ken Poshedly
3440 Everson Bay Court
Snellville, Georgia 30278
404-979-9842

BACKYARD OBSERVATORY SOIL

by Doug Kniffen Warrenton, Missouri

The term "backyard observatory" may be interpreted as referring to any small and relatively inexpensive private or club observatory. This article is concerned with the differences in soil properties that are relevant to the construction of a small building with, containing, or around a telescope mounting pier. In particular the problems associated with such structures when built on certain types of unstable soil.

> *There are two ways to determine the suitability of the soil for your choice of construction, working with the soil...and studying the soil survey.*

The reader of this article either should have or should be willing to acquire some knowledge of, and experience with, the methods of residential frame construction. No attempt will be made to teach about the reasons for the choices of materials and methods commonly employed in frame buildings except for the brief treatment given to the unique problems encountered with the floors, foundations, and piers of small observatories built on dimensionally unstable soil. These unique problems are neither properly addressed by, nor adequately solved with the techniques and reasoning behind common residential construction methods.

Very brief discussion will be given pertaining to both the identification of dimensionally unstable soils and two satisfactory methods will be suggested for accounting for soil instability in a way that is compatible with low cost wood frame observatory construction.

A good design for a small inexpensive wooden observatory would be to start with an isolated pier around which a conventionally built raised wooden floor could be constructed. Such a design would take into consideration both vibration and displacement of the floor from variable loads (moving people) as well as the thermal and associated moisture benefits of having a floor largely immune to ambient temperature changes and with air circulation underneath.

This design is totally unsuitable if the soil is dimensionally unstable. The axis of the pier can deviate considerably from vertical and the observatory could be physically torn apart if the floor supports are both attached to both the ground and the building. Lateral movement of soil with 13 inches of an A-4 rated topsoil with more than 6 feet of A-7 (the worst) rated subsoil can exceed five percent over an eight foot span and floor supports can be vertically displaced by nearly seven percent of the span distance when the supports are 1½ feet deep. An isolated half ton pier, five feet from a floor support and four feet deep, can be uplifted 20% of its depth.

Such soils are not rare enough to readily dismiss the possibility of their occurrence at your site. Dimensional change in the soil is not linear or uniform and each floor support point will be displaced independently of each other relative to another reference point such as the pier; which will itself be displaced. Additional ground contact points will complicate the picture and extra thought should be given to designing the building to include the elimination of far end independent vertical support of the rails if you have chosen the popular run off roof design for your observatory. A displacement of even two or three percent may not seem like much until you consider

AAC ACTIVITIES

OBSERVATORY REPORT

by Alex Langoussis

In November, our regular observing session was once again the victim of cloudy weather. Only Jim Brant caught the brief break in the clouds to do some observing.

The following Saturday, however, was another story, despite the bright first-quarter Moon. Six members came out to watch the midnight Moonset, then sought out the best of the winter sky. Braving the sub-freezing cold were Phil Bracken, Clay McHann, Dave Riddle, Art Russell, Eric Shelton, and myself.

Even before Moonset, we found 9th-magnitude Comet Mueller (1993a) low in the north. After a bit of lunar observing, members went about concentrating on their various agendas.

Phil Bracken, with his 15" Tectron, provided the group with the night's observing highlight. Equipped with Dave Riddle's hydrogen-beta filter, we were able to see the Horsehead Nebula in Orion! The first-timers among us were not only thrilled to see it, but also noted that the Horsehead was larger than we had imagined.

New member Art Russell spent the evening making progress towards his Messier Certificate. Having just started in August, he has logged over 50 of the Messier objects already! Eric Shelton used his 8" Schmidt-Cassegrain to explore objects on the Herschel list.

Clay McHann was searching out interacting galaxies, and observed NGCs 750-751 and Stephan's Quintet. He and Dave Riddle also spent some time exploring Barnard's Loop. Although they identified the field of the "Witch Head", both say that seeing it was considered a "maybe". Dave used the club's 20" scope to explore the Abell planetaries in Orion, his favorite being the Medusa, a PK planetary shaped somewhat like a crescent moon.

Just before sunrise, Venus, Mercury and Jupiter lined up in the east to greet the weary observers. Observing then came to a close, as nobody brought a solar filter.

OUR NEXT REGULARLY SCHEDULED OBSERVING SESSION WILL BE SATURDAY, DECEMBER 11. Those of you wishing to observe the Geminid Meteor Shower may also wish to come out on the 12th or 13th. Remember, members may use the Villa Rica site at any time. For more information, give me a call at 429-8384.

YOUR EXPIRATION DATE

*Remember....*the date of your last membership renewal appears at the upper right corner of your mailing label. Add one year to this date to get your expiration date. This date will be highlighted in color for those members who are past due.

WHERE ON EARTH DO THOSE SOUNDS COME FROM?

by Carolyn Collins Petersen, Boulder

You're sitting there in the gathering darkness of the planetarium. The show operator has just invited you to sit back, relax, and enjoy the stars. A soft reddish light is diffused over the dome, changing slowly to blue. There! The first stars appear, and with them, you hear the strains of the sometimes beautiful and unearthly music that has come to be known as "space music".

Throughout the show, you hear this music as it subtly underlines the factual content of the program, and gently takes you to the depths of space. At the end of the program, you run back to the console and ask, "What's that music? Where can I get it?"

Depending on which planetarium you're attending, you could have heard music from one of several planetarium music composers in the U.S. and Canada. These composers are Mark C. Petersen, Denver, Colorado; Jonn Serrie, Atlanta, Georgia; Barry Hayes, Richmond, Virginia; Cary Ratcliff, Rochester, NY; and Tim Clark, Toronto, Canada.

Of the five, Barry and Tim are associated with planetarium facilities, and present much of their work through the planetarium (although Tim has appeared on at least one non-space music album). In addition to his planetarium duties, Barry also tours with a theater company that is performing "Joseph and the Amazing Technicolor Dreamcoat".

Cary is a keyboard professor at Eastman School of Music, and has done his most recent planetarium composition for the Einstein Planetarium of the National Air and Space Museum, Washington, D.C.

Mark and Jonn work in recording studios, and are frequently contracted by various planetarium facilities to create soundtracks for shows. Jonn's work has been used in facilities such as the Davis Planetarium in Baltimore, Md., and the St. Louis Science Center, MO. Jonn has been featured on "Music from the Hearts of Space" - a National Public Radio program specializing in space music. He has a library of music available to planetarians - the Future Music Library.

Mark began composing space music in 1975, while at the University of Colorado. His first compositions were used in productions at Fiske Planetarium. His planetarium music library, called The Music Back-Pack Series, has been purchased and used by over 350 planetariums around the world. Mark has done custom soundtracks for several major planetariums, including the Hayden (New York City), Gates Planetarium (Denver, CO), and the St. Louis Science Center (MO). NASA News Net has also used his music under broadcasts during the1984 and 1986 Voyager 2 encounters of Saturn and Uranus.

The music that these three do is largely electronic - they achieve their sounds through the use of synthesizers. Mark's soundtracks have been enhanced by the advances in digital sampling keyboards, in particular the Emu Systems Emulator II. Jonn and Barry are exploring compositional techniques using computers and FM synthesizers. In 1985, Mark, Jonn and Barry formed a group called Celestial Rhythms, which performed several live concerts at the New York City Hayden Planetarium.

the length of nail or screw that is actually used to hold boards together.

Important soil characteristics relevant to small observatory construction come in two forms, dimensional stability and load bearing ability. There are two types of foundation/floor support solutions suggested that with minor variations will accommodate most any construction limitations encountered with different soils. The site chosen to build your observatory may or may not be suitable for particular types of construction. Whether in your backyard or a remote location the characteristics of soil can change drastically over a short distance. The problems that I have encountered with dimensional instability would not have occurred 100 yards west or would have been much less severe 20 yards north east of my observatory. Neither location was considered suitable for reasons affecting site desirability that were not related to soil .

There are two ways to determine the suitability of the soil for your choice of construction, working with the soil (which may alone by itself take several years) and studying the soil survey. A combination of working and studying is only practical for remote sites as well as more appealing to eager builders. Information in the survey will make more sense and consequently be more useful if you have spent some time familiarizing yourself with the soil at your site. Dig, scratch, crumble, pour water on and drive stakes into your soil. Do this under all combinations of hot, cold, wet or dry weather. Different types of or lack of established vegetation will affect the soil characteristics. Don't try to draw any initial conclusions from the familiarization process. When you have done enough digging and have studied the book, an understanding of the soil properties will become crystal clear.

The soil books are compiled by the United States Department of Agriculture Soil Conservation Service in cooperation with state and local agricultural agencies. The first part of each book contains text describing the characteristics and limitations for use of the various soils found in the survey area. The second part has printed aerial photos with hand drawn lines between differing soil types. You need to study the characteristics of the soils associated with type of soil indicated for your location. The maps are not one hundred percent accurate and although the book appears to be specific, most soils are variable mixtures of two or more specific types. Soil survey books are very helpful and should be studied thoroughly but don't rely on the book alone for an understanding of your site soil specifics. A topographic map should be used to determine your site location before attempting to use the aerial photo maps in the survey book. The soil book has too much useful information to cover in any one article. The names identifying each different soil type are supposedly standardized across the United States.

My site is on a ridge where soil types can change quickly in a short distance. When I consider topography, large trees and the state highway, the only practical locations for my observatory are on Marion or Keswick soils. The remainder of this article suggests two solutions that address the problems of small observatory construction on either of those soils.

The most common solution is to use a concrete floor. If the soil problem is limited to temperature-induced dimensional instability any common footing to frost line method will prove satisfactory. The floating pad method should be used if moisture is the reason for undesirable dimensional or load bearing changes in your top or subsoil. The floating pad, which will also work for frost heave, is just a flat concrete expanse cast on a flexible drainage mound.

To construct the mound, you just layer gravel of decreasing size on top of the ground and the previous layers. Start by trimming the vegetation in an area about twenty-five percent larger than the planned floor size (15' X 15' for a 12' X 12' pad). Remove any small trees but do not kill any grass or weeds, vegetation surviving construction will help stabilize the gravel. Spread a layer of 6 inch gravel in the trimmed area and follow with a layer of 4-inch, then 2-inch, then 1-inch, and finally ½-inch gravel gradually tapering the mound to the floor size. If frost heave is a problem in your area each different grade or size of gravel should be clean. The term "clean gravel" means that there are practically no pieces smaller than the rated gravel size. One or more layers of each size may be needed for thorough coverage and each layer should be properly tamped before spreading a subsequent layer. When finished the mound should be about a foot thick. A gasoline power tamper will be well worth the rental fee, especially for the two-, four- and six-inch sizes. The top one half inch layer should not be power tamped, go easy on the one-inch layer. If you are planning for buried power cables to your observatory, place the cable in an appropriate length of metal pipe at the desired location before spreading or tamping any gravel. Electrical conduit will not withstand the tamping.

It will not be possible to drive stakes and use a conventional concrete form for the floor. A concrete form can be constructed in such a way that the walls will later be attached to the form. When viewed from the end each piece of the form will look like an upside down capital "L". Nail two straight 2" X 4" boards together for each form well in such a way that they are "L"-shaped in end view, this will provide the stiffness to prevent the concrete from bowing out the form and causing problems with attaching the future walls. The six inch long side of the "L" form will be the vertical outside, the four inch side will be the top and horizontal, the inside corner will be filled with concrete. A building sixteen feet square should use a 2" X 6" for the vertical part of the "L"-shaped form wall. Extra nails through each board and in effect into the concrete will prevent the boards from slipping in the future. Do all the nailing for each form well before constructing the form and use cold galvanized nails if possible. Construct the form and level it with little pieces of scrap wood or gravel while making sure that diagonal measurements of the form stay the same, bracing will be necessary. A standard cast-in pier is not recommended for ground with moisture induced dimensional instability but a shallow cast (on, not down in the gravel) pier could be set in place and aligned at this point in construction. Add a layer of sand one-inch deep to the inside of the form before pouring in the concrete. If the weather is hot and dry thoroughly wet the sand inside of the form, additional sand may be needed if some is washed out. If when leveled the form is up in the air put some half-inch gravel and sand against the outside of the boards. Add plenty of steel for reinforcement and fill the form with concrete up to, and flush with, the top edge of the form wall. It may be necessary to physically push the concrete up under the edge of the form, and into the inside corner of the "L"-shaped form wall. Watch out for nails. Unlike conventional concrete forms this floating pad form will stay in place. Cure the casting in a manner suitable to the weather.

From this point on, the rest of the project will be safe from the problems of unstable soil. The floor may seem unusually thick for a small building, especially with the extra steel, but as mentioned earlier there may be differing vertical pressures under the floor and the concrete should be cast with the goal of being nearly strong enough to lift up one corner of the finished observatory without breaking the slab. The advantages of the concrete floor are having a stable platform with no maintenance and long life on which to place one or more telescopes. If your heaviest instrument is more than 250 pounds or your building is more than twelve feet square this floor is your best option. The disadvantages of the floating pad are high cost, difficulty of construction in a remote location, and thermal effects. The floor can take a long time to change temperature which can effect seeing and make for uncomfortable observing after a hot summer day. Additionally the pad may be cool enough by morning to cause condensation after sunrise consequently trapping a lot

OVERHEARD ON THE

INTERNET

WHAT DID GALILEO'S OBSERVATIONS REALLY PROVE?

As a newsgroup devoted to astronomical insight, I think we should all understand what Galileo's observations proved, as well as what Galileo said they proved, for his claims may seem surprisingly modest to modern observers of history. Galileo built a very clever rhetorical case (see both his *Sidereus Nuncius* and his *Dialogue on the Two Great World Systems*) that suggested very strongly that his observations supported the Copernican system. But he never claimed that his telescopic observations proved the Copernican system in the crucial sense of proving that the earth is a planet undergoing simultaneous rotational and orbital motion. The only "proof" he ever offered was the idea (recognized by even some of his contemporaries as highly suspect) that the tides of the ocean are a "sloshing" of the water in the ocean basins as a result of the earth's multiple motions.

What did his observations prove?

1. His observations of the phases of Venus proved, to almost everyone's satisfaction, that Venus orbits the Sun, not the Earth. This contradicts the Ptolemaic theory of Venus's motion, but does not contradict the Tychonic planetary theory (which the sly Galileo never mentioned) nor does it contradict the stability and centrality of the earth.

2. His discovery of the moons of Jupiter proved that bodies other than the Earth could be centers of orbital motion, again contradicting Ptolemy, but proving nothing about the state of motion of the Earth.

3. His discovery of the high relief in the lunar landscape proved, to most people's satisfaction, that the Moon was not a perfect sphere. This contradicts many Aristotelian principles and cuts some philosophical support from beneath Ptolemaic theories, but proves nothing about the state of the Earth's motion.

4. His discovery that the Milky Way could be resolved into stars suggested that the stellar universe had depth and was thus less plausibly a sphere that could rotate daily about the Earth, but it proved nothing about the state of the Earth's motion.

I would urge anyone interested in astronomy to read Galileo's little *Sidereus Nuncius*, which is available in an excellent modern English translation by Albert Van Helden (and it's in paperback). It's short, interesting, a true prose classic, and it's the true root of the modern discipline of observational astronomy. see for yourself what he claims to prove, but don't let him fool you!

Incidentally, Bradley's discovery of the aberration of starlight around 1727 was the first physical proof of the Earth's orbital motion. Foucault's pendulum first physically demonstrated the Earth's rotation (early 19c I think), and the classic test, the detection of stellar parallax, didn't come along until the mid-19c. It is, for me, one of the most fascinating things about the history of astronomy that by the end of the 1600s the Copernican motion of the earth was widely accepted-- in the complete absence of any physical proof.

Jim Lattis
Space Astronomy Lab
University of Wisconsin-Madison
lattis@jerry.sal.wisc.edu

ASTIGMATIC HELP FOR ASTRONOMERS

by David Durkee, O.D., Arlington Heights, Illinois

I just took my vacation to catch up on my professional journals and I came across an article entitled "Spectacles for microscopists and astronomers" by Peter Blue, M.D. and John Pyle, O.D. Dr. Blue is a physician and amateur astronomer who wanted to keep using his spectacles for work and play. The solution they devised was, I thought, unique, so I share some of their more salient points. If you have a lot of astigmatism and can't wear contact lenses, then here's an alternative.

Have your eyeglass lenses mounted backwards so that the concave part of the lens is to the outside, not the inside as is normal. This permits the eye's entrance pupil to get close enough to the telescope's exit pupil to appreciate the full field of the short-relief eyepiece's. Now this is a little trickier than it sounds, because in manufacturing the lens the right and left lenses have to be switched and the orientation of the lens mathematically manipulated so everything comes out right in the end. The authors suggest using glass lenses to resist scratching, and to only put the correction for astigmatism in the observing eye. The telescope's focusing ability does the rest. The idea is to make a front-surface-concave lens that corrects astigmatism and stays thin. The authors tried various combinations and preferred a +5.50 base curve lens.

If anyone would like their prescription converted so you could order the same, let me know and I'll do what I can. I can be reached at CompuServe, 70651,115.

THE REFLECTOR COMES OF AGE

Isaac Newton's design for a reflecting telescope made possible a whole new breed of powerful instruments with exciting possibilities. But the reflector was not yet a practicality, because Newton's mirror was spherical, and not very well polished. Only 16% of the light was transmitted, and only low powers could be used.

John Hadley solved several of the design's most serious problems when he produced, with the help of his two brothers, a 6" f/10 Newtonian with a novel yet steady mounting. The instrument was first demonstrated to the Royal Society in 1721. The Society was so impressed that they gave it to Edmund Halley (for detailed examination, of course) and commissioned another from Hadley.

When Halley turned in his report he said that the little telescope was in every way the equal of Christian Huygens' 123-foot aerial refractor (this was before the days of achromats). Halley reported that he was able to use powers as high as 200X, and that he had observed the shadows of two satellites on Jupiter's disk. He experienced no difficulty in detecting Cassini's division in Saturn's ring. He later saw the shadow of one of Saturn's satellites on the disk, a very difficult observation, even today.

But the most important aspect of Hadley's accomplishment is that he published his methods of polishing and parabolization, and instructed others in them. The reflector was launched on its journey from toy to mountaintop glass giants.

moisture which leads to very high humidity in the observatory around noon. In our modern industrial society it is unlikely that the trapped moisture will be as benign to mirrors as distilled water. With a concrete floor, it would be wise to plan for some form of power ventilation, because if ventilation is needed your options may be limited after construction. The thermal mass of a concrete floor is too large to rely on natural convection supplying adequate ventilation for the observatory.

With the other method the way to minimize the effects of soil instability is to use an ultra-stiff wooden floor with a wooden support frame underneath. The support frame when properly constructed using carriage bolts will act as a semi-flexible coupling between the observatory and the shifting ground. Although not tightly connected to each other, besides being constructed separately, consideration should be given to the function of both the floor and the frame as a single unit.

The box frame floor is constructed with standard floor joists and plywood. The difference of the box frame from a regular floor is the extensive use of glue and screws in addition to both the top and bottom of the floor joists being covered with plywood. The box frame method will be most familiar to the reader as a hollow core door or a uni-body car frame. The standard floor construction practice uses only nails and plywood on top and is very flexible due to the variable vertical underfloor loading encountered with dimensionally unstable soil. A shift in the floor can cause problems with the roof or dome and the door.

A potential observatory builder not thoroughly familiar with conventional frame construction may be surprised to learn that a wooden house is held together almost entirely by gravity. Structural reinforcements other than gravity are necessary for a wooden observatory.

The floor support frame should be constructed first. Start with the footings for the posts by digging four holes. Shallow holes should be used if the subsoil is unstable. If water is a problem then provide for some form of drainage for the bottom of the hole. The diameter, depth and drainage of each hole should be optimized for your site soil. Study the soil survey book and check your soil again before digging. The center of each hole should be spaced relative to the other holes a distance of 75% of the linear dimensions of the proposed floor. For example, a six by six foot hole pattern for an eight by eight foot building, a nine by nine foot pattern for a twelve by twelve floor. There are two reasons for the smaller support frame pat-

> A potential observatory builder...may be surprised to learn that a wooden house is held together almost entirely by gravity.

tern first, measured dimensional changes of the soil increase with distance, second, the corner of the building is structurally the worst place for vertical lift to occur.

The holes should be slowly back filled with mixed layers of sand and half-inch gravel about three inches at a time. Tamp down each layer firmly as you fill the hole to the original ground level, power tamping is not necessary with these holes. Build over each hole a concrete form with a level top edge and a height of six inches above ground. Drive an eighteen-inch long reinforcement rod slightly more than one foot down into the gravel. The concrete filling the form should be finished smooth on top. The vertical members of the support frame will need to slide across the footings if lateral soil movement occurs.

To construct the support frame choose lumber for the size of the building. For an eight by eight building the use of four by four vertical with two by six horizontal and diagonal members will prove satisfactory. The length of the vertical and diagonals should be kept short for the minimization of "spring effect". A maximum unbraced length of eighteen inches for vertical members and thirty-six inches for diagonal members should be adhered to. Longer vertical supports should either be made of larger lumber or additionally braced. Longer diagonal distances can be "T" braced. The two inch edge of a two by four can be attached with screws spaced six inches apart, to the center of the six-inch face along the length of the diagonal leaving about eight inches "un-T'eed" at either end of the two by six brace.

Lumber sizes should be upgraded in proportion to the square foot size of the building. assembly of frame members should be accomplished with loosely tightened carriage bolts. When properly constructed, completed, and loaded with the weight of your observatory, the frame should be able to shift slightly in response to soil changes but should not be the source of any springiness or bounce. The box frame floor is very similar to a regular wooden floor. The benefits of this construction are best illustrated with a hollow core door. The extra stiffness of the box floor is largely due to both the top and bottom of the joists being covered with plywood. No nails are used, only screws, and each surface between any two pieces of wood should be heavily glued. The wood should be very dry and the humidity low when assembling the floor. Two by six joists 16" centers will work for an eight-foot span and two by tens for a twelve-foot span. Adjust the joist spacing slightly or, if necessary, add an extra joist over each of the vertical members of the support frame.

All wood should be test fitted before assembling with glue. Start floor construction by placing sheets of plywood on the support frame with just enough nails to prevent the sheets from shifting. Assemble the headers and joists with quarter-inch by four-inch lag screws adding glue to the butt between each header and each joist as well as the area of contact with the plywood. attach the headers to the plywood first. Use 2½", number eight drywall screws every six inches. The headers should be your straightest and truest boards, no warps or twists. Add the joists starting with the center and alternately working towards the ends. Use two layers of half-inch cdx plywood to cover the framing. The long dimension of each sheet of plywood should be perpendicular to the layer above or below it. Use plenty of glue between the sheets.

Additional building stiffness can be achieved by allowing the wall sheathing to hang below floor level and be screwed to the end joists and headers. This may lead to a shorter wall depending on how you have planned to cover the exterior of your observatory but should still allow for a standard door if desired.

Holes should be drilled through both the top and bottom the floor for ventilation. At least two holes should be drilled between each joist, one near each opposite header. Plastic and metal bath tub drain screens found in the plumbing section of hardware stores are about the right size and will work nicely to fill the holes. Choose the drill bit after selecting the screens. With enough holes in the floor and a corresponding larger provision for ventilation near the top of the building, natural convection will do surprisingly well in keeping the building cool and dry inside.

The telescope will sit on the floor of the building. Support for the instrument can be your choice of tripod or wooden box pier. Isolation from the floor may be beneficial and you can choose from commercial or home made vibration pads. You might try thick cork sandwiches constructed by placing two pieces of two inch thick cork between the floor and a piece of three quarter inch thick plywood. You will need to experiment with sandwich size for the weight of your instrument, too large or too small a pad and the effectiveness will diminish.

This article was written as a response to problems encountered with my observatory. I hope this information will in some way help potential builders of small observatories. If you have had any problems with soil or construction of a small observatory I would like to hear about the problems encountered and the solutions you may have found.

Constellations

Focal lengths 28-mm to 135-mm
F/ratios f/2 to f/2.8
Film speeds ISO 400 to 3200
Exposure range 10-sec. to 30-sec.

To keep stars looking starlike, use exposures no longer than 20-seconds with a 50-mm lens (40- to 50-seconds with wide-angle lenses, 5- to 10-seconds with short telephotos). Use ISO 1600 to 3200 film to record as many stars as possible in that time limit. Stop lens down to f/2 or f/2.8.

Star Trails

Focal lengths 8-mm to 50-mm
F/ratios f/4 to f/5.6
Film speeds ISO 200 to 400
Exposure range 10-min. to 60-min.+

Use a medium to high-speed film (but not ultrafast ISO 1600 to 3200 film), f/ratios of f/2.8 to f/4 (but not ultrawide apertures of f/1.4 or f/2) and exposures of 5-minutes to an hour or more. Maximum exposure time depends on sky darkness (the darker the better) and desired effect.

PIGGYBACKED CAMERA

Starfields and Nebulae

Focal lengths 8-mm to 400-mm
F/ratios f/2 to f/4
Film speeds ISO 200 to 400
Exposure range 5-min. to 60-min.+

Use a medium to high-speed film (but not an ultrafast ISO 1600 to 3200 film), f/ratios of f/2 to f/4, and exposures of 5-minutes to an hour or more. Maximum exposure depends on sky darkness (the darker the better). "Correct" exposure for your site and favorite film will require some trial and error.

THROUGH THE TELESCOPE

The Moon

Focal lengths 600-mm to 2,000-mm
F/ratios f/4 to f/16
Film speeds ISO 25 to 200
Exposure range 1/500-sec. to 1/2-sec.

Exposures vary with lunar phase. For the Full Moon, try 1/60-second at f/11 with ISO 50 film. Double the exposure for each lesser phase:

Gibbous phase = 1/30-second,

Quarter = 1/15,

Crescent: (Wide) = 1/8, (Thin) = 1/4.

For Earthshine photos, try 10-to 60-seconds with ISO 200 to 400 film.

Lunar Close-ups & Planets

Focal lengths 5,000-mm to 30,000-mm
F/ratios f/32 to f/128
Film speeds ISO 200 to 1600
Exposure range 1/2-sec. to 10-sec.

Close-ups of the lunar terminator require exposures of 1/2- to 2-seconds, while Venus requires 1/4- to 1-second, Jupiter and Mars 1- to 4-seconds, and Saturn 4- to 8-seconds. Use fast film to keep exposures to a minimum, and enough focal length to keep image size large enough to record detail.

Deep-Sky Objects

Focal lengths 600-mm to 2000-mm
F/ratios f/4 to f/10
Film speeds ISO 400 to 3200
Exposure range 5-min. to 120-min.+

Use fast or ultrafast films and exposures as long as local sky conditions will allow. Five to 10-minutes at f/10 with ISO 3200 film will suffice for bright deep-sky objects. If skies permit, expose even longer to record maximum detail. Test rolls will help determine your site's sky fog limit.

The same time limits apply if you attach a camera to the side of a telescope. The telescope's drive will track the camera across the sky, giving you pinpoint stars no matter what the exposure duration. This type of "piggyback" photography yields superb images of starfields and the Milky Way, but is best done from a dark sky site. (See "Give Your Camera a Piggyback Ride," January 1992 *ASTRONOMY*.)

With an f/2.8 lens and ISO 400 film, a five-minute exposure will record lots of stars and some of the brightest nebulae. You could use an ISO 800 or 1600 film to grab even fainter objects, but at some sacrifice of film grain. Conversely, you could leave the shutter open longer. In a dark sky, you should be able to go 20- to 30-minutes at f/2.8 with ISO 400 film and still retain black skies. But at some point you'll run into your site's sky fog limit. Longer exposures produce brighter skies, not more stars or nebulosity.

You'll also run into sky fog when you shoot deep-sky objects through your telescope, a technique called prime-focus photography. But the time limit is much longer. Telescopes are generally no faster than f/4, with f/6 a common f/ratio for a deep-sky photo telescope. At these slower f/ratios and with ISO 400 film from a good suburban site, sky fog won't intrude for 20- to 30-minutes. Under very dark skies, you could go all night.

Ultrafast ISO 3200 films are great for prime focus shots, especially with slower f/8 or f/10 telescopes — they keep exposure times to bearable lengths (5- to 15-minutes). But even these incredible films can't avoid the sky fog limit. Ultrafast films simply get you to that limit sooner.

With deep-sky photography through a telescope, as with piggyback photography, the correct exposure is the longest one you can use without incurring objectionable sky fog. Where that exposure limit lies will depend on your site. This is why no one can tell you what the "right" exposure is. As with all types of astrophotography, the best advice is — shoot test rolls. They will give you valuable experience that no amount of expert advice or exposure tables can match. Gaining that experience and putting it to good use is part of the satisfaction of doing astrophotography.

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EXPOSURE SUMMARY

CAMERA-ON-TRIPOD

Twilight Scenes

Focal lengths 28-mm to 135-mm
F/ratios f/2 to f/4
Film speeds ISO 64 to 200
Exposure range 1-sec. to 30-sec.

For shots of the twilight colors themselves or for the Moon and planets amid the twilight, use slow- to medium-speed film and exposures around 1-second when the sky is bright to as long as 30-seconds or more during the last vestiges of twilight. Bracket exposures over a wide range.

Aurorae

Focal lengths 8-mm to 50-mm
F/ratios f/1.4 to f/2.8
Film speeds ISO 200 to 1600
Exposure range 5-sec. to 30-sec.

Aurora exposures depend on the brightness of the display and the brightness of the sky. Bright aurorae require no more than 5-seconds at f/2 with ISO 400 to 1600 film. Faint aurorae require 20- to 30-seconds and a dark sky. Bracket widely — if it's a rare bright display, don't spare the film.

GETTING THE EXPOSURE RIGHT

by Alan Dyer, *Astronomy* Magazine

Photographing the sky is a craft. The satisfaction you get from that craft comes not only from the fine images you create but also from the skills you acquire in learning to produce those images. One of the skills every astrophotographer soon develops is the ability to judge what exposures to use.

Not too bright, not too dark, but just right — learning to get well-exposed negatives or slides is the first step toward getting great astrophotos.

Photographers of daytime scenes have an arsenal of technological wonders to help them get the right exposure — light meters, auto-exposure cameras, programmable cameras. Today's cameras practically do all the thinking for you. But with night sky photography, light meters don't work — there isn't enough light for a meter to respond to.

Instead, you have to do the thinking. It's more challenging, but getting good results is very rewarding.

YOU CAN'T GO WRONG

Beginners often worry too much about getting perfect exposures. But here's a secret: for most astrophoto subjects there is no single "correct" exposure.

Only three types of celestial objects require exposures to be fairly precise: the Sun, the Moon, and the bright planets. You can get good shots of those objects by following some basic guidelines and knowing the fundamentals of f/ratios and film speeds.

With every other celestial subject, exposures can vary over a wide range and still produce pleasing results. For example, in the series of photos on pages 84 and 85 of the September 1992 issue of *ASTRONOMY* magazine, which one is the best? Is it the one we've marked as the correct exposure? You might prefer the underexposed version, or the overexposed one.

This uncertainty in exposures makes beginners a little uneasy. Without firm recommendations, how can you tell what exposure to use? Experience.

By experience, I don't mean years of dedication and self-denial! A few test rolls accompanied by careful notes will often provide you with enough experience to get good results reliably on every roll after that.

MASTERING THE FUNDAMENTALS FILM SPEED

Although picking exposures sounds like a guessing game, some basic principles put to work can help you make the right choice.

First, you have three ways to control the exposure of any shot, day or night:

- Adjust the length of time the shutter remains open (the shutter speed).
- Adjust the amount of light coming through the lens (by varying its aperture or "f/ratio").
- Or select a film with a greater or lesser sensitivity to light (a value given by the film's ISO number).

Choosing the right film for the subject is an important part of building your astrophoto skills. Fast films are more sensitive and require shorter exposures. In general slow films (ISO 25 to 100) are reserved for bright subjects such as whole-disk views of the Sun and Moon. Moderate-to-fast films (ISO 200 to 400) are good for dimmer subjects such as aurorae, starfields, and high-magnification views of the Moon and planets. Ultrafast ISO 800 to 3200 films are excellent for faint targets such as deep-sky objects photographed through a telescope.

For the purposes of calculating exposures, the important rule to remember is that when you double the film speed you cut the exposure time in half. For example, if your test rolls tell you that an ISO 100 film requires 1/60-second for a good shot of the Moon, an ISO 200 film will need only 1/125-second. An ISO 400 film would need 1/250-second, and so on.

Going the other way, an ISO 50 film would need 1/30-second, while an ultra-fine-grained ISO 25 film would require a 1/15-second exposure. It's a simple principle to remember, and a good thing too, because you'll rely upon it every time you work out exposures for each shooting session.

MORE FUNDAMENTALS – F/RATIO

Once you've elected to use a certain type of film, shutter speeds and f/ratios become your main methods for varying exposures. When you are using the camera's own lens you can vary the lens aperture. This is done using the ring marked in the following increments: f/1.4 (in the case of fast lenses), 2, 2.8, 4, 5.6, 8, 11, 16 and so on. These numbers seem arbitrary but they actually do mean something – they represent the focal length of the lens divided by the aperture. This is called the focal ratio or "f/ratio." A 50-mm lens set to f/2 has an effective aperture of 25 mm across. Stop it down to f/4 and its internal diaphragm closes to 12.5 mm across.

The smaller the f/ratio number, the wider the aperture. The wider the aperture, the more light the lens lets through, and the shorter the required exposure. In fact, with each incremental step down the scale (say from f/2.8 to f/2) the area (not the diameter, but area) of the lens aperture doubles, letting though twice as much light. Opening up one f/stop produces the same result as doubling the exposure time. For example, if your Moon shots turn out fine using a 1/60-second exposure at f/11, then at f/8 the exposure will be 1/125-second.

When you are shooting directly through a telescope, you no longer have the freedom to vary the f/ratio. The f/ratio of your scope is fixed, perhaps it's an f/4 scope, or an f/6, or f/10. In this case, the only way to vary the exposure (short of putting in a different speed film) is by adjusting the shutter speed.

THE MOON AND WORLDS BEYOND

You'll use the basic relationships between ISO speed, f/ratio, and shutter speed every time you take pictures of the Sun, Moon, and planets. Because the Moon changes phase, lunar exposures vary over a wide range but all are shorter than you might think - after all, the Moon is just a large sunlit rock.

For shots of the Full Moon, a good starting point is 1/60-second with ISO 50 film, a suitable film for such a bright object. This assumes an f/ratio of f/11, close to the f/10 focal ratio of many Schmidt-Cassegrain telescopes.

If you have an f/16 telescope (or something close to it such as an f/15 refractor) you would use 1/30-second.

If you have a faster telescope you can use a faster shutter speed. As in the example above, with an f/8 scope use 1/125-second. At f/5.6 you would use 1/250-second. But there aren't too many f/5.6 telescopes. If you have an f/5 or f/6 scope, 1/250 should work fine.

Phases less than full require more exposure. Luckily, you don't have to guess. Just follow this simple rule: Each phase less than full requires a doubling of exposure.

If 1/60-second works for a Full Moon, then 1/30 should be fine for a gibbous Moon. A First or Last Quarter Moon will require 1/15-second, while a wide crescent such as a 5- or 6-day old Moon will need 1/8-second. A thin crescent needs the longest exposure, about 1/4-, though 1/2-second wouldn't hurt. (For more information about lunar photography, see "Staging a Moon Shot," August 1992 *ASTRONOMY*.)

The 1/4-second recommendation for a crescent Moon exposes the lit crescent correctly. If you want to bring out the dim Earthshine on the dark part of the Moon, you'll need a much longer exposure and a faster film. If you are shooting through a telescope, try ISO 200 or 400 film and a 10- to 60-second exposure.

To get shots of the Sun through a telescope or long telephoto lens, you must use a safe filter over the front aperture of the scope or lens. The exposure will depend on the density of the filter, but for starters try the same exposure you use for a Full Moon.

The planets pose a special challenge. Though they are relatively bright they are very small. If you shoot directly through a telescope you'll get nothing more than a bright dot. To magnify a planet's disk enough to record detail, you need to employ a camera adapter that allows you to place an eyepiece between the telescope and the camera. Using this "eyepiece projection" technique you can get a planet disk about 2-to 4-mm across on the film frame. At the f/50 to f/100 f/ratios produced by eyepiece projection, planet exposures run in the 1/4- to 8-second range.

Venus is the brightest planet and can be snapped through a telescope with exposures as short as 1/4-second with ISO 100 film. Jupiter and Mars require shutter speeds 8 times longer (equivalent to three f/stops). This puts the exposure at around 2 seconds. Saturn is dimmer still and requires 4- to 8-second exposures. But in all cases, take lots of exposures. (For more details about planetary photography, see "How to Take a Planetary Portrait," July 1990 *ASTRONOMY*.)

STAYING OUT OF THE FOG

If you want great shots of stars and constellation patterns, simply load in a roll of fast film, put your camera on a tripod, open the lens to f/2 or so, and open the shutter for 20 seconds. If your sky is fairly dark, you'll record stars fainter than you can see with your naked eye.

To keep the stars looking starlike, don't go much longer than 20 seconds. Beyond that, the apparent motion of the sky will trail the stars into streaks. Because nature itself poses a time limit to this type of photography, you control exposure by selecting the lens aperture and the film speed. In this case, use an ISO 1600 to 3200 film. That way you'll pick up as many stars as possible during the limited time exposure.

As for aperture, most starfield astrophotos benefit from using a wide aperture. This is the same thing as saying "use a fast lens." However, even if you have a fast f/1.4 lens at your disposal you're often better off "stopping it down" to f/2 or f/2.8. This will improve the sharpness of stars in the corner of the frame, reducing the image-distorting aberrations that many ultrafast lenses are prone to when used wide open.

If you go longer than 20 seconds, stars will trail across the film. To purposely create a star trail photo, use an ISO 200 to 400 film, stop the aperture down to f/4 or f/5.6 and open the shutter for 10 minutes to an hour. How long you can go depends on the darkness of your sky. Light pollution will eventually fog the film, making the sky look an ugly shade of brown or green.

Starfield shots longer than a minute or two are out of the question for city dwellers, but from a decent suburban location you should be able to go several minutes. From a dark rural site you may be able to leave the shutter open for an hour or more.