

FOCAL POINT



The Newsletter of the Milwaukee Astronomical Society

October 1994

FROM THE EDITORS' DESK

Mary and I appreciate the favorable comments we've received from many of you concerning our first issue of *The Focal Point*. A few suggestions for changes and additions have been made that we'll be incorporating in upcoming issues. The newsletter's format will continue to change and evolve well into 1995 until we are satisfied with its look and content. In the mean time, keep reading, thinking, writing, and suggesting to help make this the best newsletter it can be. We're open to anything that may be on anyone's mind!

Last month I asked members to write a brief synopsis about their astronomical pursuits during the summer of 1994 (What I did on my summer vacation). As of this writing I have received one submission (not including my own). This month I'm asking all of you again to send along an item for inclusion in this article which will appear in the December issue. Just jot down a few lines or a couple of paragraphs and send it to us at W248 S7040 Sugar Maple Drive, Waukesha, 53186.

To those of you who regularly read *Sky and Telescope*, I'm also interested in hearing (and seeing in writing) your views concerning the piece by Patrick Thibault that appeared in the October Focal Point column on page 6, "Networks We Shall Become!". If you didn't see it, I recommend taking a few minutes to read Thibault's opinions about the future of astronomy clubs. The author's opinions are quite radical but thought provoking at the same time!

Lastly, the autumn season presents celestial observers with an enormous bounty of viewing treats. I find the combination of the late summer, fall, and early winter skies that are visible at this time of year *the* most intriguing, rewarding and challenging. It's no wonder then that over these past 20 years as an amateur astronomer I have logged the most hours at the telescope in September and October. Before our gorgeous fall weather is gone, take some time to view the night sky with binoculars, a telescope, or your unaided eye. Your efforts are sure to be rewarded.

-★Dan Koehler

A reminder that dues are due NOW! Use the renewal form and return envelope you received in early September. If you've lost the envelope mail the form immediately with your check (made payable to the Milwaukee Astronomical Society) to Paul Sorenson, Membership Chairman, W188 S8660 Brooke Lane, Muskego, WI 53150 (414-679-4339).

ASTROFEST XV "THE BEST YET"

September 9-11, 1994 marked the fifteenth anniversary of the Chicago Astronomical Society's sponsorship of Astrofest, held at Camp Shaw-Waw-Nas-See (a 4-H camp) just west of Kankakee, Illinois. Astrofest I and II (1980 and '81) were held on the grounds of the Modine-Benstead Observatory (in the town Yorkville, west of I-94 in Racine County). The Racine Astronomical Society co-

sponsored the first two Astrofests with the C.A.S. These gatherings have since been affectionately dubbed "Aquafest" (due to an overabundance of rainfall in 1980) and "Astropest" (due to an overabundance of Wisconsin's beloved flying insect in 1981). Astrofest was permanently moved in 1982 to the "Camp Shaw" site in Illinois when it was determined that the M-B-O was too impractical of a site for a gathering of several hundred amateur astronomers for an entire weekend. The C.A.S. took over sole sponsorship of Astrofest in 1982 also.

These changes have turned out to be smart ones for the C.A.S. Astrofest III (1982) had just under 100 participants, owing mostly to the new, unproved Camp Shaw site about 90 minutes south of Chicago's Loop. Attendance recovered to around 250 in 1984 when I attended my first one. Since then attendance has steadily increased each year. Over 820 amateurs attended Astrofest this year, which is a new record. Astrofest continues to be one of the "big four" national star parties along with Stellafane in Vermont, the Riverside Telescope Maker's Conference in California, and the Texas Star Party in (where else?) Texas. Among this year's attendees were at least 22 M.A.S. members spotted over the weekend. They included (in alphabetical order):

Dick Adduci, Wanda Berner, Tom Gill, Harvey and Andy Herman, Jim Hervat, Barb and Scott Jamieson, Lee Keith, Dan Koehler, Dave Kriege, Dorothy and Jim Kube, Matthew McNeely, Sally Jo Michalko, Charlotte Nelson, Tom Renner, John Schibley, Lana Silke,

Peter Smitka, and Mike and Benjamin Wolkomir. (My apologies to any M.A.S. member who attended and was not recognized in this listing. The oversight is not intentional.)

The 1994 edition of Astrofest will probably go down in history as one of the warmest. Friday evening's viewing was fair. The sky remained clear overhead until about midnight. Distant thunderstorms moved along the northern horizon (in the direction of Chicago) and to the east (over Indiana) throughout the evening. A mild rain shower occurred over the camp about 4:00 a.m. Saturday. Saturday's temperatures moved up quickly into the upper 80's to near 90, with a blistering bright sun throughout the day. Saturday evening was a little cooler than Friday night (and wetter because of a fairly heavy dewfall), but it remained clear all night right up to sunrise on Sunday.

Astrofest is primarily a telescope maker's and observer's party, and awards are presented for the most innovative and well-built instrument designs. An astrophotography contest is held annually also. **Scott Jamieson** received one of a dozen or so citations presented this year for the "construction and display of a very stable equatorial mount for a 4-inch f/15 refractor using low-tech bearings". This mount will be donated to the M.A.S. and used in the operation of the Society's Edmund refractor, which was donated by **Mike Wolkomir** several years ago. (THANKS SCOTT AND MIKE!!) Over the past 15 years, several M.A.S. members have been recognized at Astrofest with telescope making and photography awards.

It would be nearly impossible to estimate accurately the number of 'scopes scattered about the five-acre observing field this year, but a rough guess would be about 150, or one telescope per 5 or 6 attendees. What's most interesting is that each year nearly all the 'scopes present are home-built, many with unique and unusual design characteristics. That's the beauty of this event. You can gather ideas from other amateurs by examining their instruments and asking questions. I have never met a

fellow amateur at Astrofest who didn't enjoy telling me the stories behind their home-built telescope.

The other main feature of Astrofest is the "Astro-Swap and Flea Market" of both new and used equipment. In years past this took place mostly on Saturday morning, but now it begins by mid-afternoon on Friday and continues through late Saturday afternoon! Literally thousands of astronomical items are for sale or trade, from telescope parts and accessories to jewelry and crafts.

An amateur paper session was held in the main assembly hall of the camp on Saturday morning, and Richard Berry gave a presentation there on Saturday afternoon about building and using CCD cameras.

Attendees can bunk in cabins that sleep ten each, or pitch tents, pop-up campers, RV's, or vans nearly anywhere around the camp. Food is available on site to the first 250 people who register early enough, but the meals usually sell out quickly. The Northwest Suburban Astronomers from the Chicago area have served "Astrodogs" (hot dogs with condiments) on Friday evening and Saturday noon for the past two years. The other meal option, chosen by most attendees, is to bring in and prepare their own food. Those who care to can explore the more than 150 acres of Camp Shaw on their own on Friday, Saturday, or early Sunday. There are trails through the heavily forested camp that take hikers along a wide creek flowing through the site. Most attendees enjoy just lounging and relaxing around telescopes and astronomy talk in the afternoons.

Astrofest '94 was, like its predecessors, a huge success. Kudos are in order for General Chairman Mike Barrett and his staff of 39 C.A.S. volunteers and many members of two boy scout troops for their outstanding work. A new feature of Astrofest this year were the more than 90 "attendee volunteers" who signed on to help run Astrofest when they pre-registered. Several M.A.S. members assisted with event operations and were rewarded for their efforts with a very nice T-shirt.

Anyone who attended Astrofest this year will receive the 1995 registration information about mid-July. Anyone not on the Astrofest mailing list can write anytime to: **Astrofest, P. O. Box 596, Tinley Park, IL 60477.** If you're thinking about attending Astrofest XVI think seriously about pre-registering. The Astrofest committee is considering elimination of "walk-on" registration in future years, or making it *extremely* expensive to do so!

-★**Dan Koehler**

LIBRARY NEWS

There are no new books in the Observatory's collection to report this month, but I would like to put in a good word for one of last month's listings.

"To A Rocky Moon" (Wilhems, 1993) is written from an insider's view of the Apollo program. The book traces the story of NASA's lunar program from before its inception, as a response to Russian initiatives, to the gathering of the last sample of lunar crust. The book's anecdotal style provides insight into the personalities of the astronauts as revealed during their training, and later as they carried out their missions. The opposing theories of the scientists involved in the moon-landing project play out dramatically throughout the story, including the vigorous debate concerning the feasibility and wisdom of even placing a man on the lunar surface.

Interestingly, Eugene Shoemaker (of recent S-L-9 fame) had a major role in evaluating potential landing sites. He recognized early on in the project that nearly all lunar basins and craters are of impact origin.

The book emphasizes the prominent role of geology in the Apollo program, but this is explained well within laymen's understanding. The author also underscores how science was carried out in the Apollo years within the context of NASA's policies, politics, and the career goals of the astronauts and geologists involved in the project.

ANNUAL DINNER ANNOUNCEMENT

It's time once again for the annual MAS DINNER! Due to the request of members who attended last year's *spring* dinner, this year's dinner has been scheduled for the *fall*, so mark your calendar for Friday, October 21, 1994 and join us! Klemmer's Williamsburg Inn will again host our event. Last year, Klemmer's received universal praise from M.A.S. members for a beautiful guest room and *great food!*

The festivities will begin at 5:30 P.M. with conversation around a cash bar. Dinner is scheduled for 6:30 P.M., and our program will start at 8:00 P.M.

Dinner entrees include your choice of Filet Mignon, Stuffed Pork Chop, or Orange Roughy. All entrees include a salad, potato, vegetables, rolls, and beverage. Klemmer's entrees are excellent!

Our after-dinner speaker will be Dr. Robert Greenler. Dr. Greenler shares our fascination with the sky. He has extensively studied beautiful and previously unexplained or misunderstood atmospheric sky phenomena such as halos, sun dogs and sun pillars. He has traveled to the bottom of our planet to view these wonders from the South Pole! Dr. Greenler's enthusiasm is infectious, so don't be surprised if you gain a new appreciation for less than perfectly crystal clear skies! Dr. Greenler's talk, entitled HALOS, SUNDOGS AND SCIENCE will start at 8:00 P.M. Following his talk, Dr. Greenler has agreed to autograph *in a unique way*, your copy of his book Rainbows, Halos and Glories (which is now available in soft cover). If you have his book, bring it along!

Date: **Friday, October 21, 1994**
 Location: **Klemmer's Williamsburg Inn**
 10401 West Oklahoma Ave.
 Milwaukee, WI

Times: **Cocktails: 5:30**
 Dinner: 6:30
 Program: 8:00

TEAR - OFF FORM HERE AND RETAIN UPPER PORTION FOR YOUR REFERENCE

MILWAUKEE ASTRONOMICAL SOCIETY DINNER, OCTOBER 21, 1994

NAME: _____

Entree	No.	Cost ea.	Total
Filet Mignon	_____	\$17.00	\$_____
Pork Chop	_____	\$15.50	\$_____
Orange Roughy	_____	\$16.00	\$_____
		Total:	\$_____

Make your check payable to: **The Milwaukee Astronomical Society**

Mail to: Tom Renner
 2605 North University Drive, Apt. F
 Waukesha, WI. 53188

Your reservation must be received by October 17

NOTE: I plan to take the Observatory's copy of "Rainbows, Halos, and Glories" to the annual M.A.S. dinner for Dr. Greenler's "unique" autograph. If the book is out on loan at the time of the dinner (October 21), the borrower is charged with bringing it to Klemmer's that evening. *Failure to do so will result in that person being changed into a sundog!*

-★Sally Waraczynski

QUICK REMINDERS AND NOTICES

★★ **TWO FORMAL M.A.S. MEMBERSHIP GATHERINGS REMAIN IN 1994:** the annual M.A.S. Dinner at Klemmer's Williamsburg Inn on Friday, October 21 (reservations required, see insert for details in this issue) and the regular membership meeting on November 18 in the lower level meeting room of the National Regency Retirement Home, 13750 West National Avenue, New Berlin. As reported last month, Program Chairman Tom Renner (524-0932, evenings), among other members, will attempt to plan some sort of holiday get-together for December. Call Tom if you have any suggestions.

★★ **WHILE WE'RE ON THE SUBJECT OF MEETINGS,** members are reminded to forward suggestions for membership meeting site alternatives (to National Regency, that is) to Tom Renner. As stated last month, we are looking for a potential site near a freeway with availability on Friday evenings from about 7:30 to 10:30 p.m. with adequate parking and security. The site should have a meeting room or auditorium that can accommodate 75 or more people and be available for our use free of charge.

★★ **MEMBERS ARE ONCE AGAIN REMINDED ABOUT THE UPCOMING VOTE ON THE PROPOSED BY-LAWS CHANGES** at the November 18 meeting at National Regency. Refer to the mailing dated August 29 sent to all active members of record on September 1. Members who have joined since this mailing was made are encouraged to vote on

November 18 as well. M.A.S. members not in possession of the proposed changes should contact any Officer or Director and ask to obtain a copy. See the listings on the last page of this issue.

Time will be set aside at the November 18 meeting to answer any questions members may have about the proposed changes. You may also contact any Director or Officer with comments and questions prior to the meeting.

★★ **THE M.A.S. CONTINUES TO BE IN NEED OF A MEMBER TO CHAIR THE NOMINATING COMMITTEE.** As reported in the September newsletter, this person will be responsible for finding candidates for the four Board positions and all Officer positions opening next May. Additionally, this person could assist the President in recommending candidates to fill standing committee chairmanships.

Two incumbent directors will be stepping down next May, and one current director must leave the Board due to the succession rules of the by-laws. All current officers are eligible for re-election, but all may not choose to do so.

Contact M.A.S. President **Matthew McNeely** (354-5347, evenings) if you would like to volunteer for this very important job!

★★ **WE ARE STILL LOOKING FOR SOMEONE TO ASSUME THE DUTIES OF ROSTER MAINTENANCE COORDINATOR AND ALCOR.** The qualified candidate must own or have ready access to a PC with a database program (and knowledge of how to use them effectively) and the ability to print mailing labels. The Astronomical League Executive Secretary prefers to receive all changes to the M.A.S. membership roster electronically via modem now, so it would be best if our candidate's PC system to have good telecommunications capabilities as well. Contact **Matthew McNeely** (354-5347, evenings) if you can help.

★★ **IF YOU WOULD LIKE TO OBSERVE THE FALL SKIES** but don't

have a telescope, don't despair!! Remember that the M.A.S. has two loaner telescopes (8-inch Dobsonian-style reflectors, with eyepieces and star charts) available for member's exclusive use. Contact either loaner telescope coordinate for details:

Rich Sterle, 8115 West Waterford Avenue, Greenfield, 543-7459 (evenings).

Randy Welniak, 2820 North 79th Street, Milwaukee, 771-4726 (evenings).

★★ **AND WHILE YOU'RE USING THOSE LOANER 'SCOPES** (or you're own for that matter) consider trying one of the M.A.S. Observing Clubs. **Lee Keith** coordinates the operation of the Astronomical League's Messier and Herschel Club programs for M.A.S. members, as well as our own Burnham (multiple star) program. Upon fulfillment of observing requirements, the successful candidate receives a very nice certificate or lapel pin (or both in some cases). Observing programs have also been instituted for binocular users, and the M.A.S. supports these programs as well.

Contact Lee at 425-2331, evenings, for more information.

★★ **THE PUBLIC IS INVITED TO VISIT HISTORIC YERKES OBSERVATORY** every Saturday morning from October 1 to June 1. Between June 1 and October 1 the building is open Saturday afternoons.. Fall is a perfect time to take a drive to Williams Bay, on the shores of Geneva Lake, and see the grandeur of what is arguably the most beautiful astronomical observatory in the U.S. The Observatory staff conducts two guided tours of the world's largest refracting telescope, the famous 40-inch Clark refractor, each Saturday morning, at 10:15 and 11:15. Admission is free, however the staff requests a donation of \$2 per person or \$5 per family. There is a small gift shop that sells T-shirts, sweatshirts, picture postcards, meteorites, and inexpensive astronomy books and star charts.

Yerkes is located at 373 West Geneva Street (Highway 67) on the west side of Williams Bay.

1993's NEW MEMBERS (con't)

Tami Hellenbrand, Brookfield

Frank Kenney, Greendale

Peter Kirsch, Waterford

Eric Lanke, Milwaukee

Michael Malloy & Family, Whitefish Bay

Andy Manning, Milwaukee

Jim Mayer, New Berlin (rejoining)

Trisha McQuestion, Wauwatosa

Kirby Monroe & Family, New Berlin

Dr. Arun Parikh & Family, Oconomowoc (rejoining)

Joseph Payne, Milwaukee

Rene Peralta & Family, Shorewood

Benjamin Preuss-Petzlaff, Waukesha

Pamela Roper, Milwaukee

Sam Santacroce, Waterford

Sharon Schipper-Rau, Watertown (rejoining)

Robert Scott, Milwaukee

Paul Sorenson, Muskego

Kurt Sutter, Milwaukee

Greg Walter & Family, Brookfield

Richard Wasielewski, Franklin

Tyler Weggel, Milwaukee

Some of the members listed here were announced in the *Focal Point* once, but we did not have the time to check into this. At the risk of repeating some, we decided it was better to list everyone than risk leaving someone out.

So, on behalf of all the members of our great Society, welcome to all of you in "the class of '93". We hope your stay with us is an enjoyable and long one!

-★MCK/ DLK

EYE ON THE SKY FOR NOVEMBER

November is typically one of the cloudiest months of the year in Wisconsin. Nonetheless, let's not lose sight of the celestial calendar! Here are a few things to at least *know* are going on during the month, even if we won't be able to observe them!

Nov 01 -- P/Comet Borrelly is at perihelion (its closest approach to the sun) at 6:00 a.m. CST. See the synopsis of this interesting object in last month's Eye On The Sky column. There are finder charts in the October and November issues of *Astronomy*, pages 51 and 60.

Nov 02 -- The Taurid meteors reach maximum tonight at a Zenithal Hourly Rate (ZHR) of about 12. The Taurid meteor stream is derived from P/Comet Encke, which has given rise to several minor meteor showers over the many centuries it has been orbiting the sun within the inner solar system.

Nov 03 -- New moon occurs at 7:35 a.m. CST. Today marks the beginning of the second eclipse season of 1994 with a total solar eclipse occurring from the eastern Pacific Ocean, proceeding across the South American countries of Chile, Peru, Bolivia, Paraguay, Argentina, and Brazil. The eclipse ends in the South Atlantic Ocean, below the African continent. No portion of the eclipse is visible from North America. Perigee, or the moon's closest approach to the Earth, occurs today also. The coincidence of perigee and new moon means tides could be higher than normal in coastal areas.

Nov 05 -- Mercury is at greatest western elongation (18.9 degrees) this morning. Look for it 30 to 45 minutes before sunrise in the eastern sky. This is the best morning view of 1994.

Nov 10 -- First quarter moon at 12:14 a.m. CST.

Nov 17 -- The Leonid meteor shower is at its peak this evening. This is probably the weirdest meteor shower known. It is derived from P/Comet Temple-Tuttle which has a period of 33.17 years. The comet's

orbit is thought to have been greatly perturbed by a close approach to Uranus in AD. 126, sending it on regular close approaches to Earth and creating the annual meteor shower we now see. There is evidently a huge swarm of meteoric material behind the main body of the comet as evidenced by meteor storms that regularly occur just after the comet returns to perihelion. The last such occurrence was on the night of November 16-17, 1966 when observers on the west coast of the United States witnessed a rate of 150,000 meteors per hour, and as many as 40 per second! This ranks as the greatest meteor shower in recorded history. We can next expect such a burst of activity in either 1998 or 1999, when the comet again returns to our realm of the solar system. The Leonids are the swiftest travelers of all meteors at 71 km/sec, near the theoretical maximum for meteoric material. Expect a ZHR of about 10 to 15, but the Full Moon will, unfortunately, interfere with observing this year. You should expect to see at least the brighter members of this shower though. The radiant is in the "Sickle" or head of Leo, and rises about 11 p.m. tonight.

Nov 18 -- Full moon occurs at 12:57 CST. This is the "Frosty" or "Beaver" Moon. The eclipse season ends this evening with a deep penumbral lunar eclipse, which is still just barely detectable to the eye. The moon will make contact with the diverging outer edge of the Earth's shadow beginning about 10:26 p.m. on the 17th and ending about 3:02 a.m. on the 18th. This is the fourth and final eclipse of 1994. There were two excellent solar eclipses (the May 10th annular and the Nov 3rd total) in addition to a partial lunar eclipse (May 24-25) not visible in North America. Koehler's Law of Coincidence indicates that this night is sure to be a clear one (Full Moon coinciding with an unspectacular eclipse. I'll see you at the membership meeting instead!).

Nov 26 -- Last quarter moon at 1:04 a.m. CST.

Nov 28 -- Saturn is at eastern quadrature this evening, 90 degrees east of the sun and on the meridian at sunset. -★DLK

**M.A.S OFFICERS, DIRECTORS, AND
COMMITTEE CHAIRS**

PRESIDENT

MATTHEW MCNEELY, 354-5347

**VICE - PRESIDENT, DIRECTOR, & OBSERVATORY
COMMITTEE CHAIR**

JIM KUBE, 453-8858

SECRETARY, DIRECTOR, & ASSISTANT LIBRARIAN

MARY ANN TANGNEY, 327-7976

TREASURER & DIRECTOR

MARTIN BRUNET, JR., 544-1342

OBSERVATORY DIRECTOR & DIRECTOR

GERRY SAMOLYK, 529-9051

ASSISTANT OBSERVATORY DIRECTOR

PAUL BORCHARDT, 781-0169

DIRECTOR & LIGHT POLLUTION COMMITTEE CHAIR

BRIAN GANIERE, 961-8745

DIRECTOR

SCOTT JAMIESON, 896-0119

DIRECTOR, ALCOR, & ROSTER MAINTENANCE

DAN KOEHLER, 662-2987

DIRECTOR & MEMBERSHIP COMMITTEE CHAIR

PAUL SORENSON, 679-4339

DIRECTOR & LIBRARIAN

SALLY WARACZYNSKI, 321-0918

DIRECTOR

KEN WARACZYNSKI, 321-0918

DIRECTOR

VIRGIL TANGNEY, 327-7976

OUTREACH COMMITTEE CHAIR

WANDA BERNER, 691-2360

**OPEN HOUSE CHAIR, OBSERVING CLUB AND
COMPUTER USER GROUP COORDINATOR,**

LEE KEITH, 425-2331

NEW MEMBER CONTACT

SALLY-JO MICHALKO, 524-9499

PROGRAM CHAIR

TOM RENNER, 524-0932

**OBSERVATORY KEYHOLDERS FOR
OCTOBER, NOVEMBER, AND DECEMBER**

OCT 15	KEN WARACZYNSKI	321-0918
OCT 22	WANDA BERNER	691-2360
OCT 29	PAUL BORCHARDT	781-0169
NOV 05	MARTY BRUNET	544-1342
NOV 12	TIM BURRUS	783-6572
NOV 19	GREG CIESLAK	529-0548
NOV 26	BRIAN GANIERE	961-8745
DEC 03	CHRIS HESSELTINE	482-4515
DEC 10	LEE KEITH	425-2331
DEC 17	DAN KOEHLER	662-2987
DEC 24	SCOTT LASKOWSKI	421-3517
DEC 31	JIM KUBE	453-8858

M.A.S. EVENT SCHEDULE

OCT 21	ANNUAL DINNER AT THE WILLIAMSBURG INN	6:00 P.M.
NOV 02	FIRST WEDNESDAY MEETING AT THE OBSERVATORY	7:30 P.M.
NOV 14	BOARD MEETING AT THE OBSERVATORY	7:30 P.M.
NOV 18	GENERAL MEMBERSHIP MEETING AT NATIONAL REGENCY, NEW BERLIN	8:00 P.M.
DEC 07	FIRST WEDNESDAY MEETING AT THE OBSERVATORY	7:30 P.M.

DATES, TIMES, AND LOCATIONS OF THE DECEMBER BOARD MEETING AND THE MEMBERSHIP HOLIDAY GET-TOGETHER HAVE NOT YET BEEN DETERMINED.

Article and photo submissions are encouraged. Deadlines are on the 20th of the month preceding the month of publication. The editors reserve the right to alter all submissions in style, length, and content for final publication. Where practical, submissions may be held until suitable space is available in a future issue. Submissions of lengthy articles are appreciated in digital format. Please call for instructions.

Address all materials for publication, comments, and questions to *The Focal Point*, W248 S7040 Sugar Maple Drive, Waukesha, WI 53186 (414-662-2987) or FAX to the attention of D. L. Koehler at 414-636-1818. Any portion of *The Focal Point* may be reproduced and distributed with proper credit give to the publication and The Milwaukee Astronomical Society.

THE FOCAL POINT is published 10 times each year, and is the newsletter of The Milwaukee Astronomical Society, a non-profit corporation founded in 1932 and dedicated to conducting research and educational programs for its members and the general public in the science of astronomy.