Star Stuff

The Ford Amateur Astronomy Club Newsletter

Volume 5, Number 7 July 1996

HUBBLE HOMES IN ON GALAXIES

Astronomers analyzing the Hubble Deep Field — the faintest view of the universe taken with NASA's Hubble Space Telescope — have identified what may prove to be the most distant objects observed to date.

Scattered among the nearly 2,000 galaxies in the Hubble images, which were taken last December, researchers at the State University of New York at Stony Brook (SUNY) and collaborators found several dozen galaxies they believe exhibit characteristics which make them appear to be more distant than any seen previously. Six of the galaxies appear to be more distant than the farthest quasars, the current distance record holders. Their results are being published in the June 27 edition of the British science journal Nature.

The candidate galaxies are so far away they may have existed when the universe was less than five percent its present age. If this early galaxy population can be confirmed through further observations, it means that such galaxies would have formed remarkably early in the history of the universe, only a few hundred million years after the Big Bang. The images also give an estimate of how many galaxies were forming at this time in the very early universe.

In one of the first detailed studies of the statistical properties of these distant galaxies, Kenneth Lanzetta and Amos Yahil, of SUNY at Stony Brook, and Alberto Fernandez-Soto, of the University of Cantabria, Spain, have attempted to determine the distance of each of the galaxies based on their colors.

"Since light travels at a finite speed, the galaxies are seen as they were in the distant past, allowing us to study the birth and growth of galaxies versus time," says Lanzetta. "Our results have implications bearing not only on the formation and evolution of galaxies but also on the ultimate fate of the universe," adds Yahil.

The team's distance estimates rely on the relationship between speed and distance in the expanding universe. The expansion of the universe causes the light from distant galaxies to be "redshifted." This means that light which leaves a distant galaxy as blue arrives at Hubble as red because of the expansion of space. For a nearby galaxy the shift from blue to red is relatively small, but for a distant galaxy the shift is dramatic, because the light is crossing a larger volume of space.

The researchers took the colors of different kinds of nearby galaxies and redshifted them on a computer to compare with the colors of galaxies observed by Hubble. For each galaxy they assigned a "most probable" redshift based on the best match to the "spectral templates" they developed.

While the procedure is not definitive for any individual galaxy, the authors contend that it is correct for the majority of galaxies and gives a good overall view of the distribution of distances of the galaxies seen in the Hubble image. If the redshifts are correct, then the light from these galaxies was emitted when the universe was far less than one billion years old.

"I am delighted to see the images being used for such studies. The discovery of very high-redshift galaxies is a very provocative result, and extremely interesting if it is right," says Harry Ferguson of the Space Science Telescope Institute in Baltimore, MD, a member of the team that obtained the Deep Field Observations. "It's going to be extremely difficult to confirm, but that will be a high priority for the new infrared camera that is going on the telescope next February."

The Hubble Space Telescope spent ten days in December 1995 observing a single tiny patch of sky. These observations resulted in the deepest image of the sky, revealing galaxies fainter than had ever been seen before. The striking full-color image of the distant universe was unveiled at the American Astronomical Society Meeting in January 1996, and for the last six months has been the subject of intense study worldwide. ☆

HOTBEDS OF STARBIRTH FOUND

A team of U.S. astronomers working with data from the European Space Agency's Infrared Space Observatory (ISO) have discovered a clear-cut infrared signature that reveals hotbeds of star formation hidden within spiral galaxies.

Researchers presenting their results at a meeting of the American Astronomical Society in Madison, WI, say the discovery will streamline efforts to look at galaxies across the universe and easily find the areas where unusually intense episodes of starbirth are occurring.

"At the same time, the discovery may help explain why some areas within a galaxy burst forth with new stars but other similar regions remain comparatively quiescent," said Dr. George Helou, NASA's ISO project scientist and an astronomer at the NASA/JPL Infrared Processing and Analsyis Center (IPAC) at Caltech, Pasadena, CA. Helou leads a key ISO project to understand the properties and evolution of the interstellar medium of normal spiral galaxies such as our own Milky Way.

An infrared image of galaxy NGC 6946 produced with ISO data and processed at IPAC clearly shows bright areas seen at 7 and 15 microns where star formation is taking place. The galactic nucleus appears to be a hub of star birth, as are distinct areas along the galaxy's spiral arms.

Starbirth commonly takes place behind curtains of galactic dust and gas. ISO's infrared detectors, however, "see" the heat emitted from behind those curtains. The color composite image of NGC 6946 was made with data from ISO's mid-infrared camera. The instrument was built by a consortium led by Dr. Catherine Cesarsky of the CEA/Saclay Institute near Paris, France.

"We know from studying other galaxies that when they merge or collide, they create a burst of star formation. But in this case, there's no collision and no culprit to identify as the catalyst for star formation. In the absence of galactic collisions, why should there be any starburst at all. More data on this and other starburst regions from ISO and other infrared studies will help answer this question," Helou said.

Other key ISO experiments being conducted by U.S. astronomers are studies of quasars, investigations of dust debris around Sun-like stars and the birth and death of planetary systems. In addition to these experiments, more than one hundred U.S. astronomers are receiving observing time on ISO to conduct other investigations. The ISO was launched into Earth orbit November 16, 1995. ☆

NEW CLASS OF COMETS

Astronomers observing the close approach of Comet Hyakutake to the Earth in March discovered large quantities of the gases ethane and methane in the comet. This is the first time these or other molecules classified as "saturated hydrocarbons" have been found in a comet, strongly suggesting that at least two basic types of comets inhabit the Solar System. This conclusion also has potentially profound implications for scientific theories that describe the primordial conditions that led to the formation of the Sun and planets. The discovery by a team of NASA and university researchers using the NASA Infrared Telescope Facility at Mauna Kea, will be published in Science magazine.

Ethane has never before been detected in comets or in interstellar matter, the ultimate source material from which the Solar System was formed. Yet, comet investigators found levels of ethane in Comet Hyakutake that are about 1,000 times greater than can be explained if the molecules were formed by normal physical processes within the gases of the primordial solar nebula, the birth cloud of the Solar System. "The discovery of ethane was a blinding surprise," according to research team leader Dr. Michael J. Mumma of the Laboratory for Extraterrestrial Physics at NASA's Goddard Space Flight Center. The spectral lines, or identifying signature of ethane gas, "were so bright they seemed to leap off the computer screen when we got the first observation," Mumma said.

The discoveries were made on March 24, 1996, with the three-meter diameter telescope of the NASA Infrared Telescope Facility atop Mauna Kea. The investigators used a state-of-the-art instrument known as a high-resolution infrared spectrometer. The device was cooled to about minus 400 degrees Fahrenheit to achieve the needed sensitivity to infrared light, which has a longer wavelength than red light and cannot be seen with the human eye.

The unexpected ethane discovery came as the observers searched for evidence of molecules of methyl alcohol, a known constituent of other comets. However, "the emissions of methyl alcohol that we first looked at were much weaker than expected, so we decided to search for other signatures of the alcohol," said research team member Dr. Michael A. DiSanti of the Catholic University of America, Washington, DC. "But after reprogramming the spectrometer, instead of detecting methyl alcohol, we discovered ethane."

Further observations and analysis showed that ethane and methane each constitute about one percent of the frozen gases in Comet Hyakutake. (The astronomers measured radiation from gases released from their frozen state as the solid nucleus of the comet was warmed by the Sun.) "Comets that are rich in ethane must have experienced very different conditions during their birth than comets that do not contain it," Mumma said. One theory is that ethane-rich comets formed in the warmer region near the primitive Saturn and Jupiter, while those without it formed farther away from the young Sun, near the primitive Uranus and Neptune.

Another possibility is that cometary ices formed even earlier, in different layers of the original interstellar gas and dust cloud that led to the solar nebula. An even more challenging concept is that the vast sphere of comets that are believed to surround the Solar System, called the Oort Cloud, may contain comets that formed from different solar nebula — that is, stars other than the Sun. Chemical and physical processes may have been at work in any scenario, altering the properties of the material that now makes up the comet's ice.

The discovery of ethane in Comet Hyakutake will spur scientists to go back and review measurements of other comets to see if unusual blips in their data contain hints of ethane. "For example, we're going to go back and look at Comet Halley data again," Mumma said. Similar measurements of Comet Hale-Bopp, which will pass closely by Earth in March and April 1997, are scheduled for June, he added. As a comparison to comets, there are three major categories of asteroids. Some of the rocky bodies now considered to be asteroids may in fact be dead nuclei of short-period comets.

Both ethane and methane occur naturally on Earth and some other planets, and in certain meteorites, including the Murchison meteorite that fell on Australia in September 1969. While ethane is much less common than methane in the planets,it is almost equally abundant to methane in both Comet Hyakutake and in the Murchison meteorite, the researchers note. "Therefore, it is possible that the gases found in the Murchison meteorite and those found in the comet had a common origin," according to Dr. Marina Fomenkova of the University of California at San Diego. "However, the diversity of organic material in primitive meteorites and in comets shows that they formed under a wide range of conditions," she cautions.

☆

STAR STUFF
Monthly Publication of the Ford Amateur Astronomy Club

Star Stuff Newsletter
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GENERAL MEETINGS

The Ford Amateur Astronomy Club holds regular general meetings open to the public on the fourth Thursday of the month at 5:00 PM. Meetings are held at the Ford Motor Credit Company (FMCC) building, Northeast of the World Headquarters build in Dearborn, in conference room 1491, lower floor, East side of the building.

OBSERVING SITE

The Ford Amateur Astronomy Club has an established observing site, by permit, at the Spring Mill Pond area of the Island Lake Recreational Area in Brighton, Michigan located near the intersections of I-96 and US-23. Members are responsible for opening and closing the gate after the parks 10:00pm closing time. The combination for the lock should be available on our hotline number. Always close the gate behind you after 10:00pm whether entering or leaving the park.

OBSERVING HOTLINE NUMBER - (313) 39-05456

On Friday and Saturday nights, or nights before holidays, you can call the hotline number up to 2 hours before sunset to find out if we will be observing that night. Assume that any clear Friday or Saturday night is a candidate observing night unless something else is going on or none of the club officers are able to make it.

WWW PAGE

Computers inside the Ford network can access the F.A.A.C. web page at the following address: http://av3168.pd8.ford.com:8080/faac/faac.html

MEMBERSHIP AND DUES

Membership to the Ford Amateur Astronomy Club is open to both Ford and Non-Ford Motor Company employees. The general public is also welcome to join. The dues structure is as follows:

Annual Individual/Family	$20.00
Lifetime Membership	$100.00

Membership benefits include a subscription to the Star Stuff newsletter, discounts on subscriptions to Astronomy and/or Sky & Telescope magazine(s), after hour use of the observing site at Island Lake, and discounts at selected area astronomical equipment retailers.

NEWSLETTER STAFF

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NEWSLETTER SUBSCRIPTION

A yearly subscription at a rate of $12.00 is available to those who are not members of the Ford Amateur Astronomy Club. Subscriptions are free to other astronomy clubs wishing to participate in a newsletter exchange.

JULY 1996

SUN	MON	TUE	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25 FAAC Meeting	26	27
28	29	30	31			

Jul 02 Comet Kopff Perihelion (1.5796 AU)
Jul 04 Jupiter at Opposition
Jul 04 Comet Hale-Bopp at Opposition
Jul 05 Earth at Aphelion (94,512,258 miles from Sun)
Jul 07 Last Quarter Moon (2:26 pm)
Jul 08 Comet Kopff, Closest Approach to Earth (0.5651 AU)
Jul 11 Comet Kopff at Opposition
Jul 12 Moon Occults Venus
Jul 15 New Moon (11:46 am)
Jul 16 Comet Spacewatch Perihelion (1.54 AU)
Jul 16 Asteroid Victoria at Opposition
Jul 17 Venus at Greatest Brilliancy (Magnititude -4.5)
Jul 18 Asteroid 341 California Occults 8.8 Magnitude Star
Jul 18 Neptune at Opposition
Jul 23 First Quarter Moon (1:20 pm)
Jul 24 Comet Gunn Perihelion (2.462 AU)
Jul 25 Uranus at Opposition
Jul 27 Comet 1996 E1 (NEAT) Perihelion (1.31 AU)
Jul 28 Asteroid 203 Pompeja Occults 7.5 Magnitude Star
Jul 29 Moon Occults 4.0 Magnitude Star
Jul 29 South Delta-Aquarids Meteor Shower
Jul 30 Full Moon (6:07 am)
Jul 31 Comet Brorsen, Near-Jupiter Flyby (0.4785 AU)

MEETING ANNOUNCEMENT

The Ford Amateur Astronomy Club (FAAC) holds regular general meetings on the fourth Thursday of each month, except November and December. Our next meeting will be **Thursday, July 25, at 5:00 pm.** The program for the meeting has not been determined at this time.

The FAAC meets in the Ford Motor Credit Company (FMCC) building, conference room 1491, located on the lower east side of the building. FMCC is the low building immediately northeast of (but not attached to) Ford World Headquarters in Dearborn. The FMCC building is secured with a card entry system. The easiest way to enter the building for meetings is to park in the northeast lot (Employee Lot 7) and enter through the lower northeast or lower east doors. At 5:00 pm no one seems to have trouble getting in because many people are leaving around that time. At the east door you can dial 0911 on the security phone and say you are here to attend a Ford club meeting, and security will admit you. You may find your way into the building any way you see fit, but direction signs will only be posted at lower northeast and lower east doors. ☆

FAAC WWW PAGE

by Paul Mrozek (pmrozek)

In the last newsletter I mentioned that the F.A.A.C. web page is located in the "Ford Intranet." This means that only computers within the Ford network can access the following site:

http://av3168.pd8.ford.com:8080/faac/faac.html

Sorry about any confusion for those of you on the Internet who tried to load the page. However, this important source for spreading information about our club has not be overlooked. A partial mirror of the F.A.A.C. web site is currently being developed, and the address will be given in the newsletter soon. ☆

MEETING MINUTES 6/28/96

by Don Klaser

Treasurer Kevan Granat chaired this months meeting in place of President Bob MacFarland, who is on vacation. Kevan opened the meeting at 5:10 pm making several general announcements and giving a brief treasurers report.

Don Klaser gave a report on the Public Relations/Education Committee and the 6/22 Mini Star Party at Island Lake. Chuck Boren and George Korody gave a report on the telescope building program. New sessions will start again in October/November if there is enough interest. A report on the Summer Solstice Party at Doug Bock's house was given. Paul Mrozek spoke about our new web site on the Ford intranet.

During the pizza and pop break, those present introduced themselves and spoke about their current astronomical activities. After the break, George Korody and Randy Allen gave a presentation and talk on the "Sky" computer program. George and Randy went over the numerous features included in the program. The meeting adjourned about 7:00 pm. ☆

JULY SPACE EVENTS

The following July events come from the 6/29/96 edition of "Space Calendar." This calendar is compiled and maintained by Ron Baalke (baalke@kelvin.jpl.nasa.gov).

Jul 18 30th Anniversary (1966), Gemini 10 Launch
Jul 20 20th Anniversary (1976), Viking 1 Mars Landing
Jul 21 35th Anniversary (1961), Mercury 4 Launch
Jul 26 25th Anniversary (1971), Apollo 15 Launch ☆

JULY 1996 SPACE EVENTS

The following July 1996 events come from the 6/29/96 edition of "Space Calendar." This calendar is compiled and maintained by Ron Baalke (baalke@kelvin.jpl.nasa.gov). Note that launch dates are subject to change.

Jul 01 US Air Force Titan 4 Launch
Jul 01 Galileo, Orbital Trim Maneuver #6 (OTM-6)
Jul 02 Apstar-1A Long March Launch
Jul 05 Arabsat-2A/Turksat Ariane 4 Launch
Jul 07 Space Shuttle Columbia Returns to Earth
Jul 09 Arabsat-2A/Turksat-1C Ariane 4 Launch
Jul 09 Galileo, Orbital Trim Maneuver #7 (OTM-7)
Jul 09 GPS-26 Delta Launch
Jul 15 Clipper-Graham Test Flight #5
Jul 19 EHF-7 Atlas Launch
Jul 25 EHF-7 Atlas 2 Launch
Jul 25 Minuteman III ICBM Launch ☆

PHYSICS NEWS UPDATES

The American Institute of Physics Bulletin of Physics News
by Phillip F. Schewe and Ben Stein (physnews@aip.org)

BINARY ASTEROIDS: Doublet craters account for 10% of all impact structures on Earth and Venus. A prevalent theory holds that such impacts come about when a single asteroid is fragmented either when it rips through the planet's atmosphere or when it is pulled apart by gravitational tidal forces just before impact. A new study by William Bottke (Caltech) and Jay Melosh (Arizona) shows that the relatively wide separation of craters in doublet events can best be explained by supposing that tidal fragmentation into parts had occurred at some earlier stage, as with Comet Shoemaker-Levy. The researchers suggest that such weakly-bound "rubble-pile" asteroids and asteroid satellites (such as Ida-Dactyl) might be more common than we thought. (Nature, 2 May 1996.)

GALILEO PROBE: The Galileo probe that penetrated Jupiter's atmosphere in December 1995 found only a fraction of the water expected. Further analysis of the probe data has turned up additional surprises. Wind speed at the surface was clocked at 150 m/sec; at the lower depths the speed did not fall off but actually increased to 200 m/sec. Lightning at Jupiter was observed to be less frequent than on Earth. Torrance Johnson of JPL, speaking at a meeting of the American Geophysical Union in Baltimore, said that now that all of the probe data had been downloaded, new software was being installed on the Galileo spacecraft to better prepare it for upcoming tasks, such as the June flyby of the moon Ganymede. Galileo will pass as close as 900 km and will take the best-ever pictures of the scarred moon. ☆

CLEAVIS AND NUTBREAD

Episode 42: Cleavis and Nutbread Get Cosmic.

By Greg Burnett (gburnett)
With apologies to Mike Judge

We join Cleavis and Nutbread at the Michigan Department of Natural Resources 75th Anniversary Celebration at the Island Lake State Recreation Area, as they stumble upon a display of DNR equipment...

"Hey Cleavis, check this out."
"Cool! An electric boat that zaps fish! Zap! Zap! This is Cool!"
"Who-oa! If we had one of these, we could, like, go along the beach zapping the chicks, and they would, like, float right up to our boat."
"Yeah, yeah! That would be cool!"

"AAAAaaaah! Look, a dead fish nailed to a board!"
"It's not dead, dumb—s, it's, like, stuffed."
"Is it a flounder? My mom made stuffed flounder once. It didn't look like that. It wasn't nailed to a board, it was..."
"Shut up Cleavis. Let's go see what those guys are doing."

"What's it say, Nutbread?"
"Uhhh.h... 'Ford...as-trol-o-gy...club' ...uh... or somethin'..."
"Hey, maybe they'll tell our fortunes and stuff. That'd be cool!"
"C'mon, dude, let's check it out."
"Yeah, let's check it out."

"... so the Hubble Space Telescope allows astronomers to see into the cores of distant galaxies, millions of light-years away..."

"Hey, uh, Nutbread, what's that guy talking about?"
"He's talking about space, bunghole, like that empty space between your ears."
"Yeah, yeah, I heard about space in school. There's, like, nothing there, that's why they call it 'space', because, like, there's nothing there, so they call it..."
"Shut up, Cleavis!"

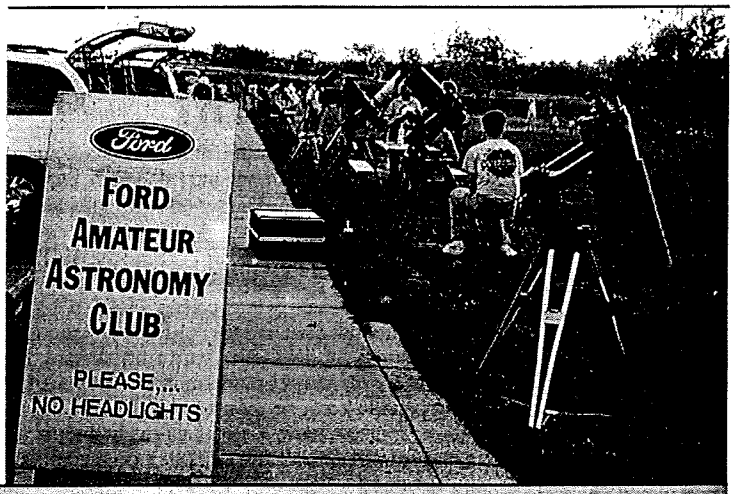
"...and using the Hubble Space Telescope we will be able to solve many mysteries of the Universe. Thanks for your attention."
"...clap...clap..."

"Hey these guys are cool."
"Yeah, these guys are cool. Hey, look Cleavis, there's the Moon. The Moon rules!"
"Yeah, yeah, I heard the Moon is made of green cheese and stuff, like, ..."
"Shut up, Cleavis. I've got some binoculars in the car, let's go get 'em."
"Yeah, that'd be cool."

THE END ☆

F.A.A.C. PHOTO GALLERY

The following pictures were taken by Patti Forton at the 6/22/96 Mini Star Party at Island Lake State Recreation Area. Color versions of these two photos can be found in the F.A.A.C. www page. Club members are encouraged to submit any astronomy related pictures (that are already in a digital format) to one of the addresses listed on page 2.



SUMMER SOLSTICE STAR PARTY

from Douglas H. Bock (DBOCK1, dougbock@KODE.NET)

June 15, 1996 - 13TH Annual Summer Solstice Star Party Report.

It was a warm summer afternoon, in the 80's and Pat and his kids had come from Gaylord, MI. They were the first to show up. We had set all the perimeter markings, made the signs, and set up the registration desk. Everything was ready, finally. Lawn was mowed, cleaning was done, and the Porta-potti was delivered. Now, we just wait for folks. About 3:00, people started trickling in. The barbeque pit was fired up at 5:00 and by this time about 40 people were there. Special thanks to John White for cooking.

I had a chance to stroll around and meet with old friends and met some new friends. I found out that several people lived right in the neighborhood, and was pleased they found us. Some new observing friends close by, maybe. While I was talking with someone, my wife and daughter conspired with many attendees, to suprise me with a birthday celebration for No. 40. Black balloons, candles, etc. They caught it all on video tape. That was fun. Special thanks to Harry and Ada for the special cake. And to my family, for adding a special memory for this party.

At 7:00 I gave a brief slide show of the Texas Star Party. By 9:00 the place was pretty full. We had an estimate of 80-90 people here. Lots of scopes set up. Jack Kennedy brought his motor home, so he and his wife were set for sleeping arrangements. The sky conditions were clear, but hazy. One of the worst non-cloudy observing sessions we have had in a long time. But, that didn't dampen any spirits, save mine. The whirr of motors and buzzing and bustling of observers started up as twilight ended. I had a chance to show some of the new people, and some of the veterans, objects of interest through the 20 inch. Someone was taking astro-photos through the 12.5 inch, most of the night, so all equipment was getting used. That was great to see. I also had a chance to look through Ryad's 6 inch refractor at Jupiter and Saturn. That was outstanding. The night rolled on, and soon dawn approached. By now, most had left, but there were still about a dozen people left. I retired for sleep at about 5:00. At 9:00, we helped Ryad break down his mount. Later, Jack and Marge left in there motor home, which was our last goodbye for this years party. Thank you all for a wondrous and enjoyable event. Next year, we are planning on making this a full weekend. ☆

ORION POLAR ALIGNMENT METHOD

from Mark Davis (mark_d_davis@usa.pipeline.com) via sci.astro.amateur

This is a slightly revised copy of a procedure I posted on sci.astro.amateur a couple of months ago. It is from a sheet Orion Telescopes published years ago. It is an iterative version of a basic two-star method, that I've found to give excellent results. Furthermore, it works well at either end of the globe; just substitute a star close to the southern pole for "Polaris", and swap North for South in the directions. It's not explained on the Orion sheet, but choosing stars on the same line of ascension (see note 1) will minimize the telescope motions, making the process quicker & easier. Note that the "northern" star does -not- have to be Polaris.

Preparation: Pick two stars that are naked-eye visible; one as close to Polaris as you can get, and another as close to the celestial equator or the ecliptic as you can get. You'll need to know the actual coordinates of these two stars. The stars recommended on the Orion sheet are Hamal (in Ares), at 2:06 +23.4 ; Eta Cassiopia, at 1:53 +63.5; Polaris at 2:12 +89.1; Thuban (in Draco) at 14.04 +64.5, and Arcturus (in Bootes) at 14:15 +19.3.

Procedure:

1. With your mount leveled, set your scope as close to Polar aligned as you can initially "guesstimate".
2. Point your scope to the southern star by "swinging" it in R.A. and DEC, so that the star is centered in the main scope eyepiece.
3. Adjust your R.A. setting circle to match the coordinates of the southern star
4. "Swing" your scope so the R.A. and DEC coordinates of the northern star are displayed on the setting circles. - if the northern and southern star R.A. coordinates are separated by 12 hours (ex., Polaris @ 2:12 and Arcturus @ 14:15) remember to swing your scope through the 90° DEC point.
5. Adjust the ALT and AZ settings of your wedge / equatorial-mount to center the northern star in your scope (you need to move your scope -MOUNT- up and down, and/or left and right, so that the northern star is centered with the R.A. and DEC settings you "swung" to in step 4... DO NOT adjust your setting circles in this step).
6. Repeat steps 2 through 5 until the northern and southern stars are centered, without further adjustments, with the correct readings on the setting circles

Note 1: For the purposes of this procedure, stars on RA lines separated by 12 hours (180 degrees) can be considered "on the same line of RA". If the star RA coordinates are separated by 12 hours, be sure to observe the requirement to swing through the 90 degree declination point in step 4 above.

After going through this sequence three or four times, you can get a very good polar alignment. It may not be adequate for long-exposure astrophotography (although Orion says you can get "astrophoto-perfect" alignment), but it's more than good enough to help you find objects using your setting circles. ☆

ASTRO LINGO

The following article was reprinted from ASTRONET, Issue 39, May 15, 1996. For more information, please contact resource@resource-intl.com.

What is "Resolving Power" ?

by Jay Reynolds Freeman (freeman@netcom.com)

"Resolving power" refers to the ability of a telescope to show detail. Even with perfectly manufactured optics, with perfectly steady air, and with as much magnification as you care to use, there is only so much detail in the image of a telescope. More magnification won't show more, just as using a microscope to look at a photographic print won't show more. The reason has to do with the wave nature of light, and is not obvious.

There are lots of fancy ways to measure or calculate things about how much detail a telescope will show. For starting out, one useful measurement, sometimes used as a definition of resolving power (though there is more to it), is the answer to the following question:

> In perfectly stable air (excellent "seeing"), with sufficient magnification, how closely spaced can the two components of a double star be such that a skilled observer can just barely see a brightness minimum between them? This test further stipulates that the stars should be of equal brightness, and neither too bright nor too faint (which works out to perhaps magnitude 5 or 6 for, say a 50mm to 150 mm aperture). Two stars thus seen look rather like two balls of clay being pushed together, or perhaps like a very obese figure-eight.

According to a famous skillful British observer named Dawes, high-quality small refracting telescopes have resolving powers, in arc-seconds, of about 110 or 120 divided by the telescope clear aperture, in millimeters. That is, a 55 or 60 mm aperture will resolve a two- second double, a 110 or 120 mm aperture will resolve a one second one, and so on — in excellent seeing, with excellent optics. Dawes's result was empirical, based on using real telescopes, but it agrees quite well with calculations based on the wave nature of light.

Bad optics reduce resolving power. Central obstructions, like the flat of a Newtonian or the secondary of a Maksutov or a Schmidt-Cassegrain telescope, may actually increase resolving power slightly for close, equally-bright double stars, but at the expense of reducing contrast for fine detail on extended surfaces (like the Moon or the planets). This result is also both empirical and mathematically calculable. ☆

SCOPE LIMITING MAGNITUDES

by Doyle Beaty (dbeaty@ECNET.ec)

The following article was reprinted from AstroNet, Issue 41, June 15, 1996. For more information, please contact resource@resource-intl.com.

There was a nice article in S&T April, 1994 about "How Faint can you See?" The article was basically about Stephen O'Meara, how he detects faint objects. For those you don't know him, he was the one who recovered Halley's comet visually. He also now claims to have viewed Hale/Bopp naked eye. When he recovered Halley he seen a field star of magnitude 20.4 with a 24" telescope in Hawaii. That may seem impossible but according to the chart below in fact its like viewing a 17th mag star with a 6" scope!!! While the article did state that Stephen's vision is above normal and he does view from the world's best sites, his real secret is simply viewing, that is staying at the eyepiece. The article states he will often spend 1/2 hour trying to detect a faint star. Most observers I've seen a star parties may spend a couple of minutes looking at or for something before moving on. The book Visual Astronomy of the Deep Sky uses magnitude levels based on the 50% level in the table below.

While the table below gives us all something to shoot for, its been my experience that there are some scope that are just plain better than others. One night while testing out the table, under 6th mag skies, I viewed a 17.4 mag star in my 14" SCT which is at about the 10% level, moving quickly to my 8" SCT I could see a 15th mag star. Thats at about the 50% level, so obviously to me while my 8" performed pretty good its not in the same league as the 14". That could be due to a lower F/ratio, bigger secondary, less contrast, a slight coma, etc.

Also with my current interest in viewing planets I notice that the longer I spend viewing a planet the more features you can see. My recent post stated I viewed 5 planets in 7 hours, Neptune and Pluto got 1/2 an hour total because their not that interesting so the other 3 planets got 6 1/2 hours. All of you who keep some sort of observing logs should be able to validate that you are able to see more now that when you first got into astronomy, practice.

In conclusion the article states there is not a clear cut formula for limiting mag. You need to train your eyes to see more and that means staying at the eyepiece, if the clouds will let you. :)

Telescope Limiting Magnitude

Aperature	Probability of Detection						
inches	98%	90%	50%	20%	10%	5%	2%
1	9.7	10.2	10.7	11.2	11.7	12.4	13.2
2	11.2	11.7	12.2	12.7	13.2	13.9	14.7
3	12.1	12.6	13.1	13.6	14.1	14.8	15.6
4	12.7	13.2	13.7	14.2	14.7	15.4	16.2
5	13.2	13.7	14.2	14.7	15.2	15.9	16.7
6	13.6	14.1	14.6	15.1	15.6	16.3	17.1
7	13.9	14.4	14.9	15.4	15.9	16.6	17.4
8	14.2	14.7	15.2	15.7	16.2	16.9	17.7
10	14.7	15.2	15.7	16.2	16.7	17.4	18.2
12.5	15.2	15.7	16.2	16.7	17.2	19.9	18.7
14	15.5	16.0	16.5	17.0	17.5	18.2	19.0
16	15.7	16.2	16.7	17.2	17.7	18.4	19.2
18	16.0	16.5	17.0	17.5	18.0	18.7	19.5
20	16.2	16.7	17.2	17.7	18.2	18.9	19.7
22	16.4	16.9	17.4	17.9	18.4	19.1	19.9
24	16.6	17.1	17.6	18.1	18.6	19.3	20.1
30	17.1	17.6	18.1	18.6	19.1	19.8	20.6
36	17.5	18.0	18.5	19.0	19.5	20.2	21.0

☆

EQUIPMENT TALK - The entire NAGLER line!

by Todd Gross (toddg@shore.net) via sci.astro.amateur

I have been playing "catch-up" after a hiatus in astronomy for many years. As many of you know, I have furiously tried out an unusual number of visual astronomy products, mainly eyepieces in the past 2-3 years..... so much so that I have been encouraged to share my experiences about equipment on the net. I have tried all Naglers, Panoptics and Superwides. I have also tried out numerous scopes, binoculars, and 3+ bino-viewers. In this edition of "Equipment Talk" I will go over all the Naglers from 4.8mm focal length on up. By the way, Nagler is pronouced with a long a sound.. Naygler, not like "hagler".

The Televue Nagler is perhaps one of the most sought after eyepieces ever, and with good reason. The wide 82° apparent field is nearly flat.. that is, images are sharp just about to the edge.. considering how large an 82° field is.. that is amazing. The feeling of "openness" is refreshing, and quite different from even a 50° apparent fov eyepiece. Al Nagler, the creator of this line of eyepieces, calls the feeling one gets when viewing through them, a "space-walk". This is something new to visual astronomy, but it is real. The effect is this: When viewing through a Nagler, particularly from 9mm on up through 20mm, you can barely take in the whole field at one time. The result is that you have to move your eye and/or you head around to truly absorb the whole view. While this can be disconcerting at first, when you are relaxed, and casually observing, you can really get a warm feeling of being able to "look around", or concentrate on different parts of space without having to move the scope!

The disadvantages of the Nagler eyepieces are few, but they do have some drawbacks. On bright objects, there is a "some" loss of contrast between the object, and the sky. Some observers say that this loss in contrast, compared to let's say a straight Plossl, will be within the object as well, so that Jupiter for instance, may not show up quite as darkly banded. I have found this to be minimal. The other disadvantages lie within specific eyepieces, and I will go over those below.

A huge advantage in dealing with Televue eyepieces, by the way, is that they can be returned for repair! I have sent in a useless 9mm Nagler, and had it returned in just over a week, good as new. The repair was reasonably priced considering the cost of the eyepiece. Here is a summary of the Nagler line:

1. The 4.8mm Nagler: This eyepiece exhibits short eye relief, approximately 7mm. It also does not give much of that "space-walk" feel compared to the longer focal lengths. Views are sharp though, if you can keep the lens clean. The field is very wide, but not as comfortable as viewing with longer Naglers. The latest version includes a full eyecup rather than the "horn" type previously supplied, and I believe a grip ring.

2. The 7mm Nagler: This eyepiece has a more reasonable 10mm eye relief. Also supplied with a very stiff, roll-down, full eyecup (like the 4.8mm) which is very effective, even more effective than the 9 Nagler and up. However, it doesn't roll down easily, and makes it somewhat harder to go from glasses to without glasses, and back. The view is very pleasant and wide, much more comfortable than the 4.8, and a bit more of that "space-walk" feeling. You only have to move your eye around, and not your whole head to take in the full 82° apparent field of view. On most scopes, this is a fantastic planetary eyepiece. Both the 4.8, and the 7mm Naglers are pure 1.25" eyepieces, and are suitable for 1.25" diagonals, and/or binoviewers.

3. The 9mm Nagler: This is the first in the series to exhibit the Nagler's more typical qualities. This eyepiece is a small 1.25"/2" hybrid design. It is a 1.25" eyepiece with a 2" "skirt". It fits more securely in a 2" diagonal, but works just fine in a 1.25". The eye relief is better, approximately 12mm. The "space-walk" feeling is full blown. The design of this and many of the Nagler's has changed so many times over the past few years it is mind blowing. From buying them second hand, and trying to match them for a bino-viewer, I have been driven nuts trying to keep track of the excellent alterations. The latest 9mm Nagler (and I believe all the others on up from here) features an easy to roll down eyecup, a contoured barrel (like the 7 and 4.8 versions - apparently to prevent eyepiece falling accidents), a grip ring, and a new placement of the top element..right on the plane of the top of the eyepiece (not at all recessed) allowing for a more comfortable eye relief, but a higher probability of eyelash contact.

4. The 11mm Nagler: No longer being produced, this eyepiece is considered a "collector's item", and draws big bucks on the second hand market. No, I have never tried one, but apparently it does not come with an eyecup. The 11mm Nagler is the Nagler 1 style, like the 4.8, 7, 9, and 13. From 9mm and up there is a slight "kidney bean blackout" effect, but it really isn't noticeable until you reach 13 (some say the 11 too), which we will discuss shortly. I have not heard that this Nagler is any "better" than others despite the high price it draws. It is considerably heavier than the 9mm, and also apparently is a 1.25/2" eyepiece.

5. The 12mm Nagler "2": When you get up around 13mm, the Nagler 1 design exhibits a more pronounced "kidney-bean" blackout effect discussed below. Therefore, Televue created a new design, similar to the 1st, which allowed the Naglers to go all the way up to 20mm, without any of the problems associated with the earlier design. The only trade off, is eye relief. While the relief is limited, the placement of the top element right at the plane of the eyepiece makes for very comfortable night-time viewing without glasses, even with the eyecup rolled up. However, with glasses, it is somewhat tight, and you will lose some of the f.o.v. I have sold, and re-purchased this eyepiece many times, always "missing" the huge panorama, and yet sharp planetary images. I could be mistaken, but the app. field of view seems even larger than 82 in this particular model. I use this eyepiece especially for observing globulars in an 8" or 10" SCT. Perfect mid-high magnification eyepiece to see the whole globular, and it's "context" yet break down the individual stars! This eyepiece is quite heavy, and also features a 1.25/2" hybrid design.I would recommend a 2" diagonal for security. I had trouble, by the way, seeing the whole field by day...for some reason it was easier at night, must have something to do with pupil size.

6. The 13mm Nagler: The last in the series 1 Naglers, the 13mm is perhaps one of the finest, and yet it has an infamous problem : The Kidney Bean effect...which incidentally is far worse by day than night. Essentially, these kidney shaped, blackout areas become prominent as you shift your view around to take in the whole view. (similar to a blackout when you get too close to a 40mm eyepiece) I have seen it claimed that if you naturally hold your eye steady, then you will not have a problem. Well, that is true, but you will also only be taking in 70°s and not 82°s, or thereabouts, (varies with observer) and that is what you are paying for. However, this eyepiece, also quite large, exhibits a very comfortable view, and good eye relief compared to the 12mm. I believe it is rated at about 19mm relief, but I found it shorter, especially when trying to view the edge of field. This eyepiece is fantastic on deep sky, giving a real Oh-wow feeling. On jupiter, I believe the sharpness on the bands was not quite as good as on other eyepieces, but I discovered that in a pretty quick and dirty test session, so I could be wrong. In a side by side test against the 12mmNagler, I thought I detected a bit more "life" and brightness to the image through the 13, but it could be because of the additional 1mm focal length. Note, that on this Nagler, as in many others, there is already a "built-in" barlow! This can be unscrewed, to gain a 30mm eyepiece or thereabouts, but I wouldn't recommend it. Firstly, the stars at the edge of field suffer greatly, and secondly, you risk ruining your eyepiece, especially since it isn't easy to screw and unscrew the built-in magnifier.

7. The 16mm Nagler 2: Almost identical in design, size, weight, and viewing characteristics (indeed the 16 is slightly SMALLER than the 12, go figure) the 16mm Nagler 2 is an awesome deep sky and planetary eyepiece. The space-walk, eye relief, and just about everything is identical to the 12. Some folks have reported some "ghosting" of bright objects with this eyepiece. I do not recall any.

8. The 20mm Nagler 2: This is a huge, heavy eyepiece, up there with the 35mm Panoptic in size, and weighing in in pounds, and not ounces. Some telescope owners can't afford that extra weight. Also, it is a 2" eyepiece, there is no provision at all for a 1.25" focuser/diagonal unlike the other Naglers. The wide top lens seems to make for a very comfortable viewing experience. However, like the 12 and 16, you shouldn't use this eyepiece with glasses, unless you are willing to sacrifice a chunk of field. Again, a similar, approximately 10mm of eye relief. The space-walk feeling is at it's maximum with this eyepiece as you have to shuttle around a lot to take in the whole picture comfortably.

However, this is one of the most important eyepieces around (and expensive), as it will give you as much field size as a 32+ mm Plossl, and yet give you a substantially more magnified, intensive view (although potentially dimmer as the exit pupil is smaller, but the contrast factor often makes up for that). If you buy this eyepiece for instance, and replace your 26mm that comes with your telescope, you will gain BOTH substantial field size AND magnification all in just one eyepiece. Indeed with a fairly high powered telescope, such as an 8" f/10, I probably would choose this eyepiece if I could choose only one (and no barlowing allowed, with a barlow I would probably choose the 27mm panoptic if I was allowed just one!)

The Panoptics from Televue, in my opinion, are even sharper in view than the Naglers! Their focal lengths are generally longer, the eye relief thus is longer, and the field size is somewhat smaller. They start at 15mm and run on up to 35mm focal length. I will go over the advantages, and disadvantages (such as the infamous "pincushion" effect) of these incredibly sharp-to-the-edge eyepieces in my next report. ☆

STATISTICALLY SPEAKING

Location (Dearborn, MI): 42°19'12" N, 83°10'48" W, 180 meters elevation
Local Time = Universal Time - 4.5 hours (Eastern Daylight Time)

Abbreviations used in reports:
FM Full Moon FQ First Qtr Moon LQ Last Qtr Moon NM New Moon
MR Moon Rise MS Moon Set SR Sun Rise SS Sun Set

July 1996

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 SR: 5:30 SS: 20:43 MR: 21:02 MS: 6:13	2 SR: 5:31 SS: 20:43 MR: 21:50 MS: 7:24	3 SR: 5:31 SS: 20:43 MR: 22:32 MS: 8:37	4 SR: 5:32 SS: 20:42 MR: 23:10 MS: 9:50	5 SR: 5:32 SS: 20:42 MR: 23:45 MS: 11:01	6 SR: 5:33 SS: 20:42 MR: None MS: 12:10
7 SR: 5:34 SS: 20:41 MR: 0:18 MS: 13:16	8 SR: 5:34 SS: 20:41 MR: 0:51 MS: 14:20	9 SR: 5:35 SS: 20:41 MR: 1:25 MS: 15:22	10 SR: 5:36 SS: 20:40 MR: 2:01 MS: 16:21	11 SR: 5:36 SS: 20:40 MR: 2:40 MS: 17:17	12 SR: 5:37 SS: 20:39 MR: 3:22 MS: 18:10	13 SR: 5:38 SS: 20:39 MR: 4:08 MS: 18:58
14 SR: 5:39 SS: 20:38 MR: 4:58 MS: 19:42	15 SR: 5:40 SS: 20:37 MR: 5:50 MS: 20:21	16 SR: 5:41 SS: 20:37 MR: 6:45 MS: 20:57	17 SR: 5:41 SS: 20:36 MR: 7:41 MS: 21:29	18 SR: 5:42 SS: 20:35 MR: 8:37 MS: 22:00	19 SR: 5:43 SS: 20:34 MR: 9:34 MS: 22:29	20 SR: 5:44 SS: 20:34 MR: 10:32 MS: 22:57
21 SR: 5:45 SS: 20:33 MR: 11:31 MS: 23:27	22 SR: 5:46 SS: 20:32 MR: 12:31 MS: 23:58	23 SR: 5:47 SS: 20:31 MR: 13:33 MS: None	24 SR: 5:48 SS: 20:30 MR: 14:37 MS: 0:32	25 SR: 5:49 SS: 20:29 MR: 15:42 MS: 1:11	26 SR: 5:50 SS: 20:28 MR: 16:47 MS: 1:56	27 SR: 5:51 SS: 20:27 MR: 17:49 MS: 2:49
28 SR: 5:52 SS: 20:26 MR: 18:46 MS: 3:50	29 SR: 5:53 SS: 20:25 MR: 19:38 MS: 4:58	30 SR: 5:54 SS: 20:24 MR: 20:24 MS: 6:11	31 SR: 5:55 SS: 20:23 MR: 21:05 MS: 7:26		Lunar Events July 7 LQ: 14:26 July 15 NM: 11:46 July 23 FQ: 13:20 July 30 FM: 6:07	

Planet View Info Report for July 1996

Date	Rise	Set	RA	Dec	Elongation	Ill Fr	DIST(AU)
Mercury							
7/ 6/1996	5:03	20:25	6h33m55s	23°58'46"	6°30'36"	0.964	1.29524
7/13/1996	5:46	20:57	7h39m44s	23°04'18"	2°30'54"	0.995	1.33392
7/20/1996	6:32	21:15	8h40m37s	20°11'57"	9°52'07"	0.936	1.31201
7/27/1996	7:15	21:21	9h33m08s	16°06'16"	16°12'45"	0.849	1.25222
Venus							
7/ 6/1996	3:38	17:58	4h44m40s	17°44'09"	32°27'22"	0.169	0.37572
7/13/1996	3:19	17:39	4h52m17s	17°41'42"	37°18'40"	0.234	0.42041
7/20/1996	3:03	17:27	5h05m41s	18°01'33"	40°44'39"	0.294	0.46934
7/27/1996	2:52	17:20	5h23m41s	18°32'43"	43°04'53"	0.348	0.52102
Mars							
7/ 6/1996	3:32	18:41	5h01m12s	22°55'23"	27°43'32"	0.974	2.31400
7/13/1996	3:23	18:36	5h22m07s	23°24'21"	29°34'13"	0.971	2.29793
7/20/1996	3:15	18:31	5h42m57s	23°42'52"	31°28'04"	0.968	2.27970
7/27/1996	3:08	18:24	6h03m38s	23°51'04"	33°25'07"	0.965	2.25927
Jupiter							
7/ 6/1996	20:23	5:32	18h54m44s	-22°54'32"	178°21'58"	1.000	4.18024
7/13/1996	19:52	5:00	18h50m53s	-23°00'22"	170°48'05"	1.000	4.18800
7/20/1996	19:21	4:28	18h47m11s	-23°05'39"	163°16'00"	0.999	4.21009
7/27/1996	18:51	3:57	18h43m47s	-23°10'16"	155°47'39"	0.998	4.24597
Saturn							
7/ 6/1996	0:29	12:37	0h28m55s	0°34'40"	97°20'18"	0.997	9.36025
7/13/1996	0:02	12:10	0h29m22s	0°35'23"	103°54'06"	0.997	9.24596
7/20/1996	23:30	11:42	0h29m30s	0°34'09"	110°33'10"	0.998	9.13487
7/27/1996	23:03	11:15	0h29m20s	0°30'59"	117°17'24"	0.998	9.02862
Uranus							
7/ 6/1996	21:38	7:13	20h23m16s	-19°59'26"	160°50'36"	1.000	18.81082
7/13/1996	21:10	6:44	20h22m10s	-20°03'14"	167°46'41"	1.000	18.78030
7/20/1996	20:42	6:15	20h21m02s	-20°07'07"	174°42'50"	1.000	18.76391
7/27/1996	20:13	5:46	20h19m52s	-20°11'01"	178°10'51"	1.000	18.76193
Neptune							
7/ 6/1996	21:11	6:43	19h54m35s	-20°19'49"	167°29'41"	1.000	29.16706
7/13/1996	20:43	6:15	19h53m48s	-20°22'00"	174°20'40"	1.000	29.14847
7/20/1996	20:15	5:46	19h53m00s	-20°24'13"	178°40'23"	1.000	29.14417
7/27/1996	19:47	5:18	19h52m13s	-20°26'25"	171°52'40"	1.000	29.15424
Pluto							
7/ 6/1996	16:31	3:46	16h05m05s	-7°16'34"	134°51'38"	1.000	29.18567
7/13/1996	16:03	3:18	16h04m36s	-7°18'05"	128°24'40"	1.000	29.27070
7/20/1996	15:35	2:50	16h04m13s	-7°20'04"	121°55'07"	1.000	29.36459
7/27/1996	15:08	2:22	16h03m54s	-7°22'31"	115°24'20"	1.000	29.46593

Planet/Moon Apsides Report for July 1996

7/ 4/1996	Earth @ Aphelion	Distance from Sun: 1.02 AU		
7/ 6/1996	Mercury @ Perihelion	Distance from Sun: 0.31 AU		
7/ 1/1996	Moon @ Perigee	Hour:17	Distance: 357974 (km)	Diameter: 0.5563°
7/16/1996	Moon @ Apogee	Hour:10	Distance: 406576 (km)	Diameter: 0.4898°
7/30/1996	Moon @ Perigee	Hour: 4	Distance: 356975 (km)	Diameter: 0.5579°

Planet Conjunction/Opposition Report for July 1996

7/ 4/1996	Jupiter @ Opposition	Hour: 19
7/11/1996	Mercury @ Superior Conjunction	Hour: 4
7/18/1996	Neptune @ Opposition	Hour: 19
7/25/1996	Uranus @ Opposition	Hour: 2

Meteor Showers Report for July 1996

Date	Meteor Shower	ZHR	RA	DEC	Illum. Frac.	Longitude
7/ 7/1996	Capricornids	5			0.50	106°
7/14/1996	Capricornids	5	20h44m	-15°	0.01	113°
7/19/1996	alpha-Cygnids	5	21h00m	48°	0.15	118°
7/25/1996	Capricornids	5	21h00m	-15°	0.72	123°
7/28/1996	delta-Aquarids	20	22h36m	-17°	0.96	126°
7/30/1996	Piscis Australids	5	22h40m	-30°	1.00	128°

SKY & TELESCOPE NEWS BULLETINS

from the editors of SKY & TELESCOPE magazine

RIPPLES IN THE CRAB

Images from the Hubble Space Telescope have revealed waves spreading away from the central pulsar in the Crab Nebula that change in a matter of days. Located in Taurus, the Crab has been steadily growing since its progenitor star exploded 900 years ago, but until now the expansion could only be detected over long time spans. Jeff Hester and Paul Scowen (Arizona State University) used a series of Hubble images to create a movie of sorts. It shows the luminous wisps brightening and fading, much like widening ripples in a pond. The wisps develop as the pulsar's powerful magnetic field spreads equatorially away from the star; charged particles in the gas clouds spiral around the field lines, emitting light in the process. Closer to the pulsar, the Hubble images also show a wobbling shock front ahead of a high-velocity jet rushing outward from the collapsed star's pole. Hester says these views will likely yield new clues for the processes behind high-energy flows throughout the universe.

PICTURES FROM POLAR

Scientists at NASA's Goddard Space Flight Center are "thumbs up" over the images they're receiving of Earth's auroral zones from the Polar spacecraft. One sequence from April 9th tracks the progress of an intense auroral storm over the Northern Hemisphere. The aurora borealis, or northern lights, actually form a ring around the north magnetic pole, and the celestial fireworks we see in the sky are the glowing response of our atmosphere to charged particles cascading in from the magnetosphere. Polar carries ultraviolet cameras, as well as an X-ray imager, to record the activity over both the north and south auroral ovals.

THE FAMILY OF LALANDE 21185

At a meeting of the American Astronomical Society, George Gatewood of Allegheny Observatory announced evidence for not one but two planets around a star in our neighborhood. Lalande 21185, 8.2 light-years away, is the sixth-nearest star to our Sun. Gatewood bases his claim on two sets of observations: a 50-year sequence of photographic plates taken by Allegheny's 30-inch refractor, and 8 years of tracking with an ultraprecise photometer. After allowing for the star's parallax and proper motion, Gatewood sees a 30-year wobble in the star's motion, implying that a Jupiter-mass planet circles Lalande 21185 at a distance of 11 astronomical units — an orbit slightly larger than Saturn's around our Sun.

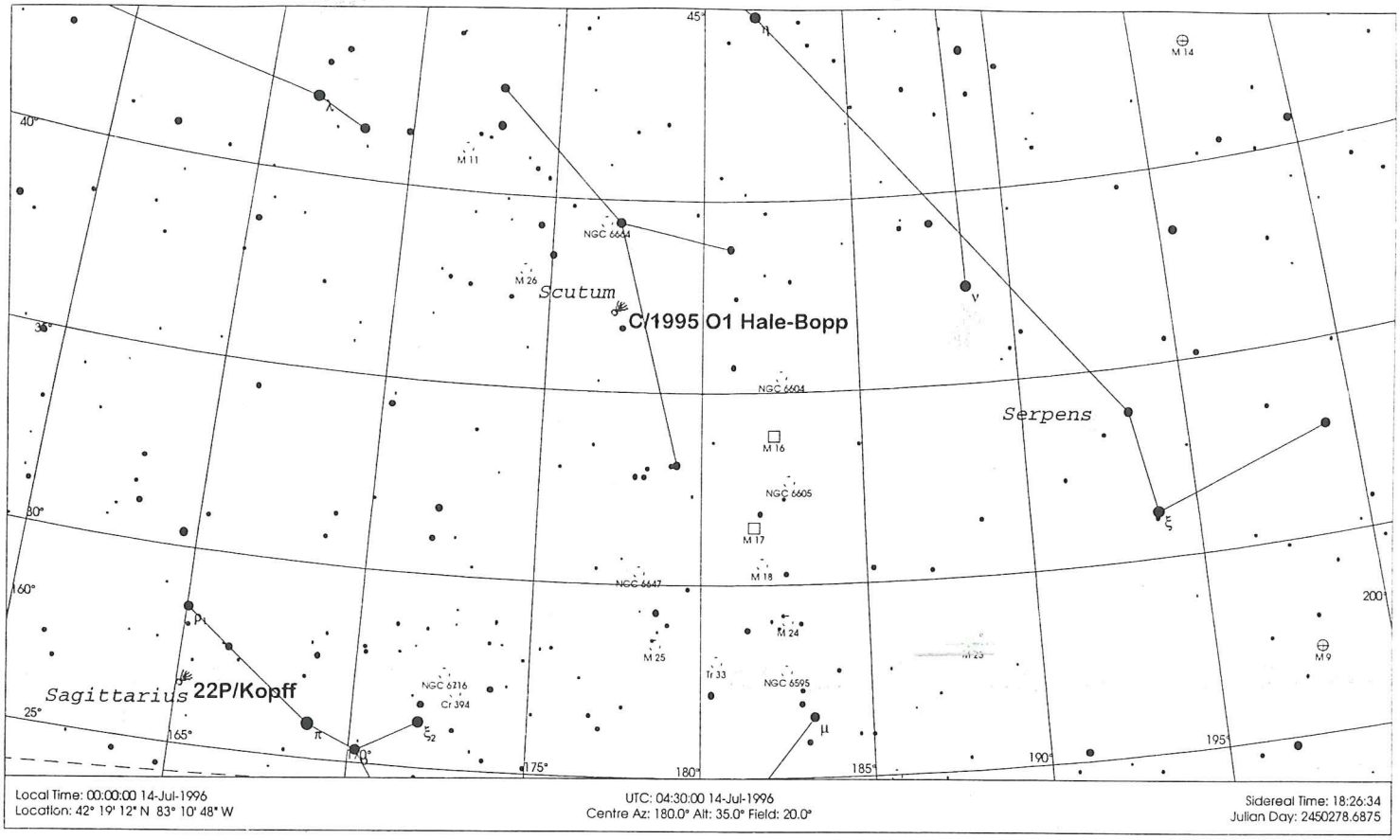
What's more, the photometer data also hint that a second body, slightly lower in mass, is about 2.2 a.u. from the star. Since the orbits appear to be titled by at most 30 degrees to our line of sight, each planet should be causing the star to move toward and away from Earth at 25 to 30 meters per second. But at least one team has watched Lalande 21185 spectroscopically for just this type of motion, without success. Lalande 21185 has a visual magnitude of 7.5 and is located in Ursa Major at right ascension 11h 3m 20s, declination +35d 58.2'.

ISO's INFRARED UNIVERSE

Launched last November, the Infrared Space Observatory is a joint project of astronomers in Europe, the U.S., and Japan. ISO's mission hasn't been totally flawless: energetic particles have diminished the sensitivity of some detectors, and back in May an accidental two-minute glance at Earth threatened to overheat the spacecraft. But, by and large, ISO has been getting rave reviews. Cooled by liquid helium, the spacecraft can obtain images and spectra out to wavelengths of 200 microns, which covers everything from the reddest stars to cold molecular clouds. For example, images at the shorter, "hotter" wavelengths reveal star-forming sites in several galaxies like M51, the Whirlpool.

But ISO's spectrometers are the real workhorses on this mission. The spacecraft has already shown that ordinary water is ubiquitous in our galaxy. Water had been detected before in interstellar space, but its sources could not be pinpointed. ISO's spectrometers have now revealed water in the gaseous envelopes of newly formed O and B stars and, conversely, in the remains of stars near the ends of their lives. And practically everywhere it looks, the spacecraft sees the spectral signature of organic compounds called polycyclic aromatic hydrocarbons, or PAHs. ☆

FINDING COMET HALE-BOPP AND COMET KOPFF



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