The Ford Amateur Astronomy Club Newsletter

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HUBBLE FINDS A STELLAR GRAVEYARD

Peering deep into the globular star cluster M4 with NASA's Hubble Space Telescope, Canadian and American astronomers have discovered a large number of "stellar corpses," called white dwarf stars, which may be used eventually to refine age estimates of the universe.

The observation, made by a team led by Harvey Richer of the University of British Columbia, Vancouver, Canada, was so sensitive that even the brightest of the detected white dwarfs was no more luminous than a 100-watt light bulb seen at the Moon's distance (239,000 miles).

The Hubble results will allow astronomers to refine theoretical predictions of the rate at which white dwarfs cool — an important prerequisite for making reliable estimates for the age of the universe and our Milky Way galaxy, based on white dwarf temperatures. Present estimates for the universe's age range from eight to twenty billion years, and refining this value is a key goal for modern astronomy and the Hubble telescope.

A white dwarf is the burned-out core of a collapsed star that, like a dying ember, slowly cools and fades away. However, the universe is not yet old enough for any white dwarfs to have cooled off completely to become invisible black dwarfs. White dwarf temperatures can therefore be used as "cosmic clocks" for estimating the age of the universe independently from other techniques.

A globular cluster like M4 contains hundreds of thousands of stars visible with ground-based telescopes. "We expected that the typical globular cluster should also contain about 40,000 white dwarfs. However, white dwarfs are extremely faint, and to date no ground or space-based telescope has been able to reveal more than a handful of them in any star cluster," said Richer. By exposing with Hubble's Wide Field and Planetary Camera 2 for five hours, Richer's team was able to detect more than 75 white dwarfs in one small area of M4. Analysis of the Hubble images was done with computer software developed by Peter Stetson at the National Research Council of Canada, Victoria, British Columbia. The faintest white dwarfs are 40 times fainter than the brightest ones in the cluster.

"Even longer exposures with Hubble could conceivably reveal the ages of the faintest and oldest white dwarfs in M4. This would be a crucial way to distinguish between recent divergent values for the age of the universe, since its age cannot be less than the age of the oldest white dwarfs in M4," said team member Howard Bond of the Space Telescope Science Institute in Baltimore, MD.

A white dwarf contains most of the original mass of a star, but has contracted to an extremely dense and faint object about the size of the Earth. A golf ball-sized piece of a white dwarf would weigh more than a ton. Because of its small size, high density, and initially hot temperature, it takes billions of years for a white dwarf to radiate all of its residual heat into space.

Located 7,000 light-years away in the direction of the constellation Scorpius and visible in a pair of binoculars, M4 (the fourth object in the Messier catalog of star clusters and nebulae) is the nearest globular cluster to the Earth. Globular clusters like M4 were born early in the history of the Milky Way, and today are veritable stellar retirement communities. M4 is so ancient (estimated to be 14 billion years old) that all of its stars that began with 80% or more of the Sun's mass have already evolved to become red giants, followed by a collapse to a white dwarf. (Our Sun will not become a white dwarf for another five billion years.)

Details of the M4 study will be published in the Astrophysical Journal Letters in September. Other participants in the research are Gregory Fahlman, Rodrigo Ibata, and Georgi Mandushev (University of British Columbia), Roger Bell (University of Maryland), Michael Bolte (University of California, Santa Cruz), William Harris (McMaster University), James Hesser (National Research Council of Canada), Carlton Pryor (Rutgers University), and Don VandenBerg (University of Victoria).

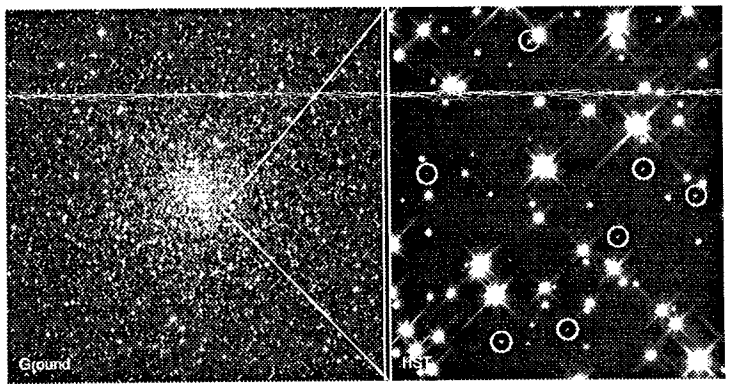

Photo Release No.: STScI-PRC95-32 • August 28, 1995 • H. Bond (ST ScI)

HUBBLE IDENTIFIES WHITE DWARF POPULATION IN M4

[Left] - A view of globular cluster M4 (fourth object in the Messier catalog of star clusters and nebulae). The nearest globular cluster to Earth (7,000 light-years away), and containing more than 100,000 stars, M4 was the target of a Hubble Space Telescope search for white dwarf stars. Ancient red giant stars are predominant in this view from a ground-based telescope. The field is 47 light-years across. The box (right of center) shows the small area that Hubble telescope probed. Credit: Kitt Peak National Observatory 0.9-meter telescope, National Optical Astronomy Observatories; courtesy M. Bolte (University of California, Santa Cruz)

[Right] - A Hubble Space Telescope color image of a small portion of the cluster only 0.63 light-years across reveals eight white dwarf stars (inside blue circles) among the cluster's much brighter population of yellow sun-like stars and cooler red dwarf stars. Hubble reveals a total of 75 white dwarfs in one small area within M4, out of the total of about 40,000 white dwarfs that the cluster is predicted to contain. The Hubble results will allow astronomers to refine theoretical predictions of the rate at which white dwarfs cool — an important prerequisite for making reliable estimates for the age of the universe and of our Milky Way galaxy, based on white dwarf temperatures. The image was taken with the Wide Field and Planetary Camera 2. Credit: Harvey Richer (University of British Columbia, Vancouver, Canada) and NASA ✪

ULYSSES DETECTS SUN WAVES
from Jet Propulsion Laboratory, RELEASE: 95-109

Periodic oscillations originating from deep within the Sun's interior have been detected for the first time in interplanetary space by the Ulysses mission to the poles of the Sun. The discovery was reported in a July 1995 issue of Nature magazine by three scientists, Drs. Louis J. Lanzerotti, Carol G. Maclennan and David J. Thomson, from Bell Laboratories in Murray Hill, NJ. The measurements were made by particle detectors onboard the Ulysses spacecraft, a joint NASA-European Space Agency mission to study regions of the Sun never before explored.

In addition to finding that these signals affect energetic particles far from the Sun, the scientists reported that their experiment was able to identify oscillations, or wave motions, that have long been sought — but never detected — by Earth-based observers. "This is a breakthrough for studies of the Sun, the interplanetary medium and the detrimental effects of energetic particles on terrestrial systems," said Lanzerotti, who is the principal investigator of the Ulysses particle detector experiment.

Solar physicists imaging the Sun through narrow-band optical filters have spent decades measuring this life-giving center of the solar system — an ordinary star in mass and age — as it writhes, churns and resonates with sound waves rising up from deep within its interior. Like a cymbal when it is struck, the Sun vibrates to produce a number of discrete "musical" tones simultaneously. These tones represent waves that travel through the Sun and arrive at the surface, much like seismic waves caused by earthquakes, which propagate through the Earth's crust to the planet's surface. At the surface of the Sun, these sound waves appear as weak inward and outward motions, said Dr. Edward J. Smith, Ulysses Project Scientist for the U.S. portion of the mission at NASA's Jet Propulsion Laboratory, Pasadena, CA.

Much of scientists' knowledge of the Earth's interior comes from studying these waves, a scientific discipline known as seismology. The discovery of solar oscillations about 20 years ago revolutionized the study of the Sun by providing a new means for probing the Sun's interior, a relatively new field of inquiry known as "helioseismology." Scientists believe that such wave motions are also characteristic of stars other than the Sun, and they are actively searching for stellar oscillations.

The Ulysses scientists did not use solar images to identify the oscillations but rather analyzed energetic particle measurements in search of narrow bandwidth tones. Using a sophisticated method of analysis, they found a large number of tones corresponding with those identified by solar observers. Tones cluster around wave periods of about five minutes, Thomson said. Each five-minute period represents the time it takes for the Sun's motion to change from moving outward to moving inward and then back outward again. These waves are equivalent to normal sound waves traveling through the Earth's atmosphere, but the periods are too long for the human ear to hear. In addition, the rarefied gas in space is not expected to transmit sound waves from the Sun to distant spacecraft like Ulysses, which is currently about 176 million miles from the Sun.

Lanzerotti and his co-investigators said their signals are probably the result of the effects of the solar motions on the magnetic fields which originate in the Sun's interior and are stretched outward into space by the solar wind, a continuous outward flow of particles from the Sun's uppermost atmosphere known as the corona. "As the magnetic lines of force oscillate in response to the passage of the waves, their motion is communicated to the energetic particles traveling along them," Lanzerotti said.

In an attempt to confirm their particle results, the investigators also sought the corresponding motions of the magnetic field. When they studied magnetic field measurements from spacecraft using the same method of analysis, they found corresponding tones in the magnetic field data.

An even more surprising result of the energetic particle analysis was the presence of oscillations with even longer periods of about three hours. Waves with these periods have been sought by solar observers since they were first predicted to exist theoretically. Once observed, they can be used to probe even more deeply into the solar interior than is possible with the shorter, five-minute oscillations.

"Observations of these oscillations in the energetic particle data are truly astounding," Smith said.

STAR STUFF
Monthly Publication of the Ford Amateur Astronomy Club

Star Stuff Newsletter
P.O. Box 7527
Dearborn, Michigan 48121-7527

1995 CLUB OFFICERS

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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.

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 Recreation Area, 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. Subscription are free to any other astronomy clubs wishing to participate in a newsletter exchange.

OCTOBER1995

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 Orionid peak	23	**24** 	25	26 FAAC Meeting	27	28
29	30 	31				

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, October 26, at 5:00 p.m.** 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 floor on the east side. 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 door or lower east door. At 5:00 pm no one seems to have much 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 that you are here to attend a Ford club meeting, and security will admit you. You may, of course, find your way into the building any way you see fit, but direction signs will only be posted fromthe lower northeast and lower east doors. ✪

PRESIDENT'S CORNER

from Chuck Boren (cboren)

Our newsletter is a forum for our members in which you as a member may contribute subject matter related to astronomy to other members. Any astronomy related information you might know of or have developed, like Tim Kelpaczyk's article from the August meeting, would be appreciated. Our newsletter is just that, ours. And though the internet information in it each month does more than fills up space, it doesn't reflect the expertise our club has in the way of astronomical activities. So I would like to invite anyone in our club who may have taken a vacation for astronomy purposes, or relate some interesting observing sessions or activities and submit it to Paul Mrozek our editor. It can be anything related to astronomy. If you need inspiration glance through Astronomy Magazine for types of ideas. ✪

STAR STUFF CLASSIFIEDS

NOTE: The following equipment is advertised "as is." The F.A.A.C. does not endorse or offer any guarantee or warranty for the items being sold. Club members may advertise astronomy related items without a fee, but must contact the newsletter to rerun the ad. Non-members may advertise for a fee of $5 per issue (checks made out to the Ford Amateur Astronomy Club).

For Sale:
Celestron Powerstar II C-8 Schmidt-Cassegrain telescope; Perfect condition! Foam fitted case, tripod, wedge, wheels, dew shield, accessory tray, accessory case, 13mm Plossl, 26mm Plossl, 7mm Ortho, Celestron Motodec, Celestron Motofocus, Telrad reflex sight, Moon filter, Tuthill micro-drive, manual, certificate, all original literature. $1600. Call Kevin at 313-662-1577. ✪

OCTOBER TRIVIA

by Harry A. Kindt (3521.1710@compuserve.com, or hakindt@aol.com)

Oct 01 1847 Maria Mitchell discovered a comet later named after her.
1958 NASA inaugurated
Oct 02 1984 Soviet Cosmonauts return to Earth after 237 days in space.
Oct 03 1943 Third V4 launch attempted (first successful).
1985 First flight of space shuttle Atlantis.
Oct 04 1957 Sputnik 1 (USSR), first manmade space satellite, launched.
1959 Luna 3 (USSR), first satellite to photograph the distant side of the Moon, launched.
Oct 05 1882 Born, Robert Hutchings Goddard, rocket pioneer.
1959 Luna 3 (USSR) returned images of the Moon's far side.
Oct 09 1977 Soyuz 25 (USSR), launched.
Oct 11 1968 Apollo 7 (US), launched.
Oct 12 1950 Born, Ronald E. McNair, second black US Astronaut.
1964 First space mission involving multiple crew members (USSR).
Oct 13 1984 US National Commission on Space, created.
Oct 14 1947 Sound barrier broken (Chuck Yeager).
1976 Soyuz 23 (USSR), launched.
Oct 15 1984 First photographic evidence of another solar system.
Oct 17 1956 Born, Mae Jernison, astronaut.
Oct 18 1959 Soviets announced their probe took photos of Moon's far side.
Oct 19 1899 Robert H. Goddard first speculated on space travel to Mars.
Oct 20 1632 Born, Sir Christopher Wren, English astronomer & architect
1786 First astronomical field expedition in US.
Oct 22 2137BC First recorded Solar eclipse (China).
1975 Venera (USSR) returned the first photos of Venus' surface.
Oct 24 1601 Tycho Brahe, Danish astronomer, died.
1851 Uranus' moons Areil and Umbriel discovered (Lassell).
Oct 26 1968 Soyuz 3 (USSR), launched.
Oct 28 1970 US and USSR officials agree upon space rescue cooperation.
Oct 31 1930 Born, Michael Collins, astronaut.

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OCTOBER 1995 EVENTS

The following October 1995 events come from the 8/26/95 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.

Oct 01 First Quarter Moon (10:36 am EDT)
Oct 06 5th Anniversary (1990), Ulysses Launch
Comet Jackson-Neujmin Perihelion
Oct 08 Full Moon (11:52 am EDT)
Punumbral Lunar Eclipse, Visible from Asia
Oct 09 Draconids Meteor Shower
Oct 12 XTE (X-Ray Timing Explorer) Delta 2 Launch
Oct 16 Last Quarter Moon 12:26 pm EDT)
Oct 17 Comet Schwassmann-Wachmann 3, Closest to Earth (0.9328 AU)
EHF-F6 Atlas II Launch
Oct 18 Seastar Pegasus Launch
Oct 22 Orionids Meteor Shower peaks
Oct 24 New Moon (12:36 am EDT)
Solar Eclipse, Visible from Southeast Asia & Indonesia
Oct 26 STS-74, Atlantis, 2nd Mir Docking
Oct 29 Daylight Savings Time ends (2:00 am) last Sunday.
Oct 30 First Quarter Moon (4:20 pm EST) ✪

ASTRONOMY LECTURES

The following colloquium seesions are free and open to the public.

Friday, October 27th, 1995. 3:00 pm- 4:00 pm, 2:30 pm refreshments.
"The Interstellar Medium and Star Birth"
by Dr. Donald Bord of University of Michigan-Dearborn.

Friday, November 3rd, 1995. 3:00 pm- 4:00 pm, 2:30 pm refreshments.
"NURO and the Initial Mass Function of Massive Star Formation"
by Dr. Kathleen DeGioia-Eastwood of Northern Arizona University.

Both sessions will be held in 144 SB on the U of M-Dearborn campus. For further information, contact Scott Jaynes (sjaynes) at 313-32-30843. ✪

WEATHER AND ASTRONOMY

from Todd Gross (Toddg@shore.net)

Starting April 1, 1995, I began publishing a 12-month series of articles devoted to Weather and Amateur Astronomy. This month's feature is DAYTIME OBSERVING & The Weather, a look at the observation of stars and planets in broad daylight, and the best weather to do it! Please note, that while I may speak authoritatively, I am just an amateur astronomer, like you, and all the information above reflects my personal opinion(s) only based on my experiences to date.

One of my favorite aspects of my astronomical hobby is shocking people as to what can actually be observed, not by night, but by day. Of course the Sun, and the Moon are obvious targets, but my favorite daytime activity is watching the planets, or even splitting double stars! There are a few tricks that can make watching stars and planets by day much easier to do, which I will share, and I will explain how the weather plays a very big role in the success or failure of your daytime adventure. Any discussion of daytime planet observing should start with Venus. Given totally clear skies, that is the kind of skies following a cold frontal passage, or right before a strong High Pressure system moves in, you will be able to find Venus in daylight... not just with your scope, but with the naked eye, AT ANY TIME OF DAY! This of course is assuming that Venus is beyond -4 magnitude, on either side of inferior conjunction. How do you find Venus?

Simply knowing where Venus is, using an astronomy program, or an Atlas, you can then sweep that part of the sky with binoculars. Be careful NOT to point the binoculars towards the sun. As long as Venus is over 15 degrees from the sun, you will have little difficulty finding it, if your binoculars are perfectly focused at infinity. 7x50s or better are recommended. Once you see the "airplane" that is stationary, carefully find some distant object to "line it up to". A tree, telephone pole, steeple, etc. will work nicely. Once you have Venus perfectly aligned with a terrestrial object, you will have no problem, seeing it with the naked eye. In the binoculars, you may or may not be able to make out it's actual phase, depending on it's size at the time you are viewing it. If it is larger than 40 arc seconds, in crescent phase, you should be able to do it! Then, turn your telescope on Venus to better view the changing phases of the planet!

For bright stars, and Jupiter, Mercury, Mars, and Saturn you will have to use a telescope to best view during the daytime. Best daytime viewing occurs in the hour after sunup, and the hour before sunset, but still in broad daylight. To find your favorite planet, do it the lazy man's way: Find it at night, and have your scope track it into daylight while you sleep! You can also use setting circles, digital setting circles, or a computer guided scope like the LX200 to find daytime objects, but it is easier to start this way. As an example, Have your scope all set and tracking on Sirius at let's say 4AM, then go back to sleep, and wake up at 8am with Sirius still in the scope!

If your scope is tracking properly, it will hold the object either in the eyepiece, or at the very least in a good finder. For a better view of the star or planet, especially when approx. 90 degrees from the sun, ONE polarizing filter can be rotated (by rotating the eyepiece that has the filter on it) until the sky darkens, but the object does not. The way the atmosphere scatters light, a polarizing filter will filter out much of the blue from the sky in this manner, leaving you with something that appears closer to twilight in the scope. I find daytime observing easier in larger scopes, by the way. My 8" far outperforms my 3". The biggest kick of all this fall though, may be as you track Castor, the double star into the daytime. Again, weather plays a role. If the air is steady, as it should be in the early part of the day, in the middle of a broad High Pressure cell, then you will be able to split Castor into it's two distinct stars in broad daylight. In fact, with the glare cut back, in some cases, you may actually find it EASIER to split than usual!!!

Exactly what magnitude stars can be seen by day? Apparently the limit runs from 1st to 4th magnitude, depending on the brightness of the sky. The closer to sunrise, and sunset, the dimmer the stars that can be detected. Indeed, several minutes before sunset this fall, you will be able to see many of Jupiter's moons through your scope! Can you see a shadow crossing as well? I haven't tried it, but I bet you could! What do these objects look like by day? Admittedly, besides brilliant Venus, the planets are visible, but get quite "washed out" looking in most cases. That is why this works best closer to sunrise or sunset. Stars, however, seemingly "shrink" in size, but remain "starlike".. in viewing Vega during daylight this past weekend, I couldn't help but note how it looked like a plain ol' nightime star. By they way, higher power darkens the sky, and will help on contrast with daytime stars and planets as well. How does the weather come into all this? Well, unlike nightime observing, basically only a narrow set of circumstances will allow for easy daylight observation:

1. Clarity: The air must have good clarity, that is, it must be perfectly clear. A high deck of cirrus clouds will play havoc when trying to find daytime stars. So will any substantial haze. Usually you find the right kind of weather after a cold frontal passage, or in a high pressure, fair weather cell.

2. Stability: Unfortunately, the air is not always stable when it becomes perfectly clear in the weather scenario presented above. You need the air to become somewhat steady in order to see daytime stars and planets well. In fact, if there is too much turbulence, it will knock that "point source of light" of a star, into a scattering of light which will get lost in the daytime brightness. With this in mind, the absolute best weather would be under the broad dome of a High Pressure cell, even a weak one, in order to achieve maximum clarity AND stability.

With nightime observation by the way, are outlined in previous articles, you can get away with poor clarity from haze and still view planets well, OR you can get away with poor stability, and still view deep sky well. In the daytime however, you generally need BOTH factors going for you for better success! So are you going to try it? Why not? Wait for a clear, calm day this fall and find your favorite star! Sirius will be an easy target, rising well before sunrise, but traversing the meridian early in the morning. Got Sirius, how about Betelgeuse? Got it? How about the Orion nebula..... well now we're pushing it aren't we?

ASTRO TRIVIA

by Paul Mrozek (pmrozek@pms061.pms.ford.com)

Q: What is Bode's Law

A: Bode's law is a mathematical sequence that describes the semi-major axes of the planets in order from the Sun. It was originally invented by Johann Titius von Wittenberg (1729-96), who included the sequence in his 1766 translation of a book by the Swiss naturalist Charles Bonnet. To help illustrate Bonnet's thesis about the divinely inspired order of nature, Titius added a paragraph about the planets which showed their distances from the Sun follow a fixed formula when measured in astronomical units (AU - the distance between the Earth and the Sun). The sequence is as follows: start with the series 0,3,6,12, ... and then add 4 and divide the result by 10.

Original series	Add 4	Divide by 10
0	4	0.4
3	7	0.7
6	10	1.0
12	16	1.6
24	28	2.8
48	52	5.2
96	100	10.0
192	196	19.6
384	388	38.8

Remarkably, the first seven numbers in the last column roughly match, except 2.8 AU, the semi-major axes of the planets known in the 18th century. Titius's book was unfortunately not widely read, and it was the better-known German astronomer Johann Bode (1747-1826) who made the law famous. In 1772, Bode published an introduction to astronomy that included the formula, without mentioning either Bonnet or Titius. He also suggested a search begin for a planet at 2.8 AU.

Belief in a physical basis for the law increased in 1781 by William Herschel's discovery of the planet Uranus at 19.18 AU. Three years later, Bode finally credited his sources and reiterated that something must exist in the empty space between Mars and Jupiter. In 1801, Giuseppi Piazzi discovered Ceres, the first and largest of the asteroids, which revolve around the Sun at 2.77 AU. Astronomers tried to use Bode's law to help locate Neptune, but it proved to be an anomaly in the sequence when French astronomer Urban Jean-Joseph Le Verrier (1811-77) discovered it in 1846 at 30.06 AU. It was not until 1930 when Clyde Tombaugh (1906-) discovered Pluto that the next predicted distance was filled.

(continued on page 5)

(continued from page 4)

Distance from Sun predictedby Bode	Actual distance from Sun	
0.4 (AU)	0.39 (AU)	Mercury
0.7	0.72	Venus
1.0	1.00	Earth
1.6	1.52	Mars
2.8	2.77	(asteroids)
5.2	5.20	Jupiter
10.0	9.54	Saturn
19.6	19.18	Uranus
	30.06	Neptune
38.8	39.44	Pluto

Bode's law is presently thought of as a coincidence. Human ingenuity and properties of numbers make it very likely that some sequence can be made to match no matter what the actual orbits. For example, the German astronomer Johannes Kepler (1571-1630) had some success in fitting the orbits of the first six planets to nested Pythagorean solids. One would expect that some sort of vaguely geometric sequence for the planetary orbits, and Bode's law is vaguely geometric.

An even better formula is the orbital resonance law, which states that orbiting bodies tend to have orbital periods (the orbital period is proportional to the mean distance to the 3/2 power - Kepler's third law) that form integral resonances with neighboring satellites. This law accurately matches the observed distances, including Neptune, with an average error of only 4%. In the following table, the resonance value is the nearest integer that matches the ratio of the satellite's orbital period to its inner neighbor.

Planet	Resonance	Actual Distance	Predicted Distance
Mercury		0.39	
Venus	5:2	0.72	0.72
Earth	3:2	1.00	0.94
Mars	4:2	1.52	1.59
Ceres	5:2	2.77	2.80
Jupiter	5:2	5.20	5.10
Saturn	5:2	9.55	9.58
Uranus	6:2	19.19	19.86
Neptune	4:2	30.11	30.46
Pluto	3:2	39.53	39.46

In addition, this law also predicts the orbital distances for the large, and most of the small, moons of the outer planets. Thus, it seems that simple resonances may provide some reason for Bode's law.

References:
The Friendly Guide to the Universe, by Nancy Hathaway.
Oxford Illustrated Encylopedia of Astronomy, by Jaqueline Mitton.
Comments from Erik Francis, Michael Gutzwiller, and Joseph Larkin in the sci.astro USENET newsgroup.

ASTRONOMY WORKSHOP

The following article was reprinted from ASTRONET, Issue 21, September 1, 1995. For more information, please contact resource@rahul.net.

HOW TO CLEAN MIRRORS AND LENSES
by Lenny Abbey (labbey@mindspring.com)

The cleaning of optical surfaces, especially those of first-surface mirrors, is the most delicate and exacting task which the astronomer is called upon to perform. At the time of cleaning, a lens is most vulnerable to damage; damage which cannot be re paired. Yet if a telescope is to perform at its greatest potential, cleaning must be done time to time. I have used the following method for over twenty-five years without adding a single scratch to the surface of my mirrors and lenses. It has the advantage of requiring only materials which are readily available at the neighborhood pharmacy or grocery store. The cost is less than twenty-five cents per cleaning.

First you must realize that usually the best advice on cleaning mirrors and lenses is ... DON'T DO IT. Dirt and grease which are adhering to the surface of mirrors and lenses may degrade image quality, but they will not damage the delicate optical surface until they are moved against it. Removing dirt without allowing it to rub against the underlying optical surface is what makes cleaning such a tricky task. If your mirrors and lenses are so dirty that they must be cleaned, then this is the way to do it:

FOR MIRRORS

1. Blow all loose dirt off with "Dust Off" or another canned clean air product. Take care not to shake the can while you are using it, and be sure to release a little air before using it on the optical surface. This will assure that no liquid is dispensed to make things worse! You can use a rubber bulb for this purpose, but it is not nearly as effective.
2. Prepare a VERY dilute solution of mild liquid detergent (e.g., Dawn). Use about 2 - 4 drops per liter (quart).
3. Rinse the mirror off under a moderate stream of luke-warm water for two or three minutes. Test the temperature of the water with your wrist, just as you would when warming a baby's bottle.
4. Make a number of cotton balls from a newly opened package of sterile surgical cotton. Soak 2 or 3 balls in the detergent solution. Wipe the surface of the wet mirror with a circular motion, going first around the circumference, and then working your way towards the center. The only pressure on the cotton should be its own weight. For this first "wipe" you should use several fresh sets of cotton balls.
5. Throw cotton balls away.
6. Repeat process with new cotton balls, using a LITTLE more pressure.
7. Rinse mirror thoroughly under running tap.
8. Rinse mirror with copious amounts of distilled water (do this no matter how clean or "hard" your tap water is).
9. Set mirror on edge to dry, using paper towels to absorb the water. Keep replacing the paper towels as the mirror dries.
10. If any beads of water do not run to bottom, blow them off with Dust Off, or the rubber bulb.
11. Replace the mirror in its cell, being careful to keep all clips and supports so loose that the mirror can rattle in the cell if it is shook.
12. Spend the next month realigning your scope.
13. If you do anything more than this, you will damage the coating, and maybe the glass. You should not have to clean an aluminized mirror more often than once per year. Do NOT over clean your optics.

FOR OBJECTIVE LENSES

DO NOT UNDER ANY CIRCUMSTANCES REMOVE A LENS FROM ITS CELL, OR THE CELL FROM THE TELESCOPE. This restriction means that the above procedure must be modified. Only the front surface can be cleaned. If you remove the cell from the telescope, you will be in big trouble. There are probably not more than 25 people in the United States who can effectively collimate a refractor!

1. Blow loose dirt off using the above precautions.
2. Soak the cotton balls in a 50:50 solution of a commercial glass cleaner containing ammonia, such as Windex, and water. Squeeze slightly so that the balls are not dripping wet.
3. Wipe front lens surfaces with the wet cotton, using only the pressure of the weight of the cotton balls. Follow immediately with dry cotton, using little or no pressure.
4. Repeat procedure, using slightly more pressure.
5. Blow off any cotton lint that remains on the surface.
6. Repeat procedure if lens is not clean, but if one repeat does not do it, give up and leave it as is.
7. Inspect lens to make sure that no cleaning solution has found its way into the lens cell, or between the elements. If this has happened, leave the telescope with the lens uncovered in a warm room until it is dry.

FOR EYEPIECES AND BARLOWS

Follow the procedure given for objective lenses, but use Q-Tips (cotton on plastic sticks) instead of cotton balls. You may, of course, clean both surfaces. The eyebrow juice on the eye lens of eyepieces may require repeated applications. I think that this is OK in this case.

SOME DONT'S

1. Do not use any aerosol spray product, no matter who sells it, or what their claims are.
2. Do not use lens tissue or paper. It DOES scratch.
3. Do not use pre-packaged cotton balls, they frequently are not cotton.
4. Do not use any kind of alcohol, especially on aluminized surfaces.
5. Do not use plain water.
6. Do not use any lens cleaning solution marketed by funny companies, like Focal, Jason, or Swift. Dawn and Windex (or their equivalents in other countries) are cheap and commonly available.

PARTLY OVERCAST

The follwing article was reprinted from ASTRONET, Issue 20, August 15, 1995. For more information, please contact resource@rahul.net.

THAT THIN CLOUD? WILL IT GO AWAY?
by Alister Ling (Reprinted from the April 1993 Hamilton Centre "Orbit")

In short, no. Most observers have recognized this pattern: thin high clouds, or cirrus, lie along the horizon but disappear as night falls. Frequently, this is an illusion. As a meteorologist, I have watched thin cirrus on satellite imagery march across reporting stations with nary a change overnight, yet the observer reports clear, or very scattered high cloud.

This phenomenon has now been confirmed by a 4-year study of satellite imagery. There is no diurnal, or day to night change in semi-transparent cirrus. The only exception to this is in summer, when cirrus formed by thunderstorms has a tendency to evaporate gradually through the night. The illusion can be explained by an analogy to M57, the Ring nebula. One can think of the nebula as a uniform spherical shell of gas that is mostly transparent. Looking through the center, we can see that there is little absorption. However, as we look along an edge, our line of sight encounters sufficient material to produce a noticeable veil.

The same thing happens when we look at the sky. Overhead, the cirrus is so thin it is in effect transparent, but as we look slantwise through it towards the horizon, the cloud shows up. If it is dark, the stars still shine through, but the Milky Way loses much of its impact. The situation is no different with summer haze.

Numerous times I've overheard observers saying how lucky we are to be free of haze overhead but are surrounded on all sides. If you are willing to admit it to yourself, you will easily notice that extended objects like M31 just don't have the detail you are used to seeing. The best advice I can give for you is to accept what you've got and observe high surface brightness objects like planets, clusters and planetary nebulae. You have ventured into the night to relax, so don't fret.

ISLAND LAKE REPORT

by Paul Mrozek (pmrozek)

Our 3rd Annual Island Lake Star Party was last month on Saturday, September 2. The event was held at the scenic Spring Mill Pond area located within the park (see picture below). Even though conditions were mostly cloudy at dusk, including a few sprinkles of rain, I still set up my telescope with the hope that there might be some breaks in the sky. I think Sky & Telescope magazine once defined this type of observing as "sucker-hole astronomy." Anyway, my optimism paid off when one of the persons next to me let me borrow his 2" diagonal and eyepieces (thanks Chris). The view through my Celestron Ultima 8" with this equipment was incredible!

Another extraordinary view that night was through someone's pair of night vision binoculars. One interesting thing I noticed was that when I looked at a clear patch in the sky through the binoculars I was surprised to see some high thin clouds. This condition is described in the above article titled "Partly Overcast". Overall, I still had a great time, and I was reminded that even poor conditions at Island Lake are better than my usual backyard observing site.

GALILEO UPDATE

from NASA HQ Public Affairs Office, RELEASE: 95-147

NASA's Galileo spacecraft is plowing through the most intense interplanetary dust storm ever measured as it closes in on Jupiter after a six-year journey to reach the giant planet, scientists report. This is the latest and greatest of several large dust storms encountered by Galileo since December 1994, when the spacecraft was still almost 110 million miles from Jupiter. The current storm has lasted more than three weeks. The spacecraft, launched in October 1989, is now about 39 million miles from the planet. Galileo will enter orbit around Jupiter December 7, 1995.

During the current dust storm, Galileo has counted up to 20,000 dust particles per day, compared to the normal interplanetary rate of about one particle every three days, said Dr. Eberhard Grun, principal investigator on the spacecraft's dust detector experiment. The particles, scientists say, are apparently emanating from somewhere in the Jovian system and may be the product of volcanoes on Jupiter's moon, Io, or could be coming from Jupiter's faint two-ring system. The dust particles, probably no larger than those found in cigarette smoke, may also be leftover material from Comet Shoemaker-Levy 9, which impacted Jupiter last year.

Scientists believe the particles are electrically charged and then accelerated by Jupiter's powerful magnetic field. They have calculated that the dust is speeding through interplanetary space at velocities ranging from 90,000 to 450,000 miles per hour, depending on particle size. Even at such high speeds, these tiny particles pose no danger to the Galileo spacecraft, scientists say. Galileo's dust detector, one of 10 science instruments on the spacecraft, is about the size of a large kitchen colander. It counts particle impacts and observes their direction and energy. From these measurements scientists can estimate particle size and speed.

Grun, a scientist at the Max Planck Institute for Nuclear Physics, Heidelberg, Germany, also has dust detectors aboard the Ulysses spacecraft that flew by Jupiter in 1992 on its way to study the Sun, and on the Cassini spacecraft scheduled for launch to Saturn in 1997. His team first discovered dust emanating from Jupiter in 1992 using the Ulysses instrument. The Galileo instrument first observed dust coming from Jupiter in June 1994. Although both Ulysses and Galileo were able to show that the dust storms seem to come from Jupiter, the intensity and timing of the recent storms seen by Galileo differ from those detected by Ulysses.

Chances of understanding the nature of these dust storms are improving since, after the onset of the current storm, Galileo flight engineers commanded the spacecraft to collect and transmit dust data as often as three times a day, according to Dr. Carol Polanskey, team chief for the dust instrument subsystem at NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA. The normal collection rate had been twice per week. In addition, the instrument was reprogrammed in July 1994, "to take advantage of the knowledge gained from the Ulysses experience and just in time to observe the start of the series of storms Galileo has seen," said Polanskey.

The reprogramming also endowed the instrument with new data compression and other improvements, she added. "This puts us in an excellent position to view the dust phenomena as Galileo moves toward Jupiter," she said. "We're looking forward to determining the source of the dust storms once we get into the Jovian system."

When Galileo arrives at Jupiter this December, it will receive and relay the data from the atmospheric probe that was targeted toward Jupiter and separated from the main spacecraft in July. Galileo will then begin a two-year, 11-orbit survey of Jupiter, its satellites, magnetosphere and the dust environment. ✪

PHYSICS NEWS UPDATE

from The American Institute of Physics Bulletin of Physics News (physnews@aip.org)

UPDATE #220 (04/03/95)

During a full Moon Earth's average global temperature is 0.02 K warmer than during a new moon. Robert Balling and Randall Cerveny at Arizona State were able to correlate daily measurements of global temperature for the period 1979 to 1994 with the 29.53-day lunar cycle. The scientists assert that their results underscore both the accuracy of daily global temperature readings and the notion that the lunar phase needs to be considered in studies of short-term temperature variability on Earth. (Science, 10 Mar)

UPDATE #240 (09/18/95)

by Phillip F. Schewe and Ben Stein

Juptiter has a transition zone in its interior where an envelope of mostly molecular hydrogen (H2) gives way to a deeper mantle of atomic (unpaired) hydrogen. Some scientists believe that perhaps most of the hydrogen at this lower level is metallic in nature, a fact which could account for Jupiter's strong magnetic field. Several new studies, attempting to simulate a small sample of Jupiter here on earth, suggest that current theories of the Jovian interior may have to be revised. The terrestrial work tries to match the conditions of pressure (thousands and millions of atm.) and temperature (thousands of K) prevailing inside Jupiter. Experiments with high-pressure diamond anvil cells and with high velocity guns—sending shock waves through containers of liquid hydrogen (W.J. Nellis et al., Science, 1 Sept)—and computer simulations of the interactions among liquid hydrogen molecules (Ali Alavi et al., same issue of Science) all have sought to calculate the speed of sound through hydrogen under extreme conditions.

The new studies are at odds with velocity estimates derived from observations of oscillation modes in Jupiter's surface; e.g., the shock experiment finds that molecular hydrogen dissociation occurs at lower pressures than predictions based on the oscillation data. Further work is needed because of the astrophysical importance of hydrogen, which forms the bulk of stars and some planets. ✪

NEW SOLAR SUNSPOT CYCLE

from California Institute of Technology, Office of Media Relations

PASADENA-The first sunspot in the new sunspot cycle was identified on August 12, by astronomers at the California Institute of Technology's Big Bear Solar Observatory in Big Bear City, California. The new sunspot marks the end of the sun's quiescent period and the beginning of a new surge of sunspot activity. "This makes us happy," said Hal Zirin, professor of astrophysics at Caltech and director of the Big Bear Solar Observatory. "The sun is a lot more interesting to study when things are going on."

Sunspots are relatively dark spots that typically appear in groups on the surface of the sun. They are associated with strong magnetic fields and with solar flares, and follow an approximately 11-year cycle of increasing activity followed by a slow decline into a quiescent period. Early in the cycle, sunspots appear rarely and at relatively high solar latitudes around 30 to 35 degrees, then increase in frequency and appear at lower latitudes until they reach sunspot maximum. After this peak in activity, the number of sunspots slowly declines, and they appear ever closer to the sun's equator until they reach a relatively quiet phase called sunspot minimum.

There is typically some overlap between successive sunspot cycles. As the last sunspots of one cycle appear near the equator, at latitudes of about 7 degrees, the next cycle starts again with sunspots near 30 degrees, but with the magnetic polarity of the new spots reversed. That's exactly the point the sun is at now; it has been in a quiescent period through much of 1994 and this year, with a few spots showing up near the equator. The new sunspot photographed on August 12 appeared at a solar latitude of 21 degrees, and its magnetic polarity is opposite to that seen over the last decade, a key to identifying it as the manifestation of the start of a new cycle.

This new sunspot appeared a bit earlier than astronomers expected. Typically, as a solar cycle winds down, late bursts of sunspot activity will appear near the equator before the new cycle starts. Scientists had seen these late sunspots in 1984, but saw little late activity this time and therefore expected an early beginning to the new cycle, but not this early.

Sunspots have effects far beyond the sun itself, so while solar astronomers are excited by this news, people in many other fields are keenly interested as well. Solar flares often occur above sunspots, and can disrupt radio communications on earth and sometimes even cause widespread power outages. Flares also cause the colorful celestial displays known as the northern (or southern) lights, and cause unusual behavior in satellites, such as increased drag and disabled orientation. Sunspots in the new cycle should rapidly become more common and reach a high level of activity in 1998 or 1999. ✪

ASTRONOMY PRODUCT REVIEW

by amcneely@aol.com (AMcNeely)

The following article was reprinted from ASTRONET, Issue 23, October 1, 1995. For more information, please contact resource@rahul.net.

"National Audubon Society Pocket Guide: Constellations".
by Dr. Gary Mechler, Dr. Mark Chartrand.
Astronomical Charts by Wil Tirion.
1995: Chanticleer Press, Alfred A. Knopf, Inc.
$7.99

This is a nice little book for beginning astronomers. It consists mainly of a series of maps displaying all of the Northern Hemisphere constellations. Each constellation gets its own full page map plus mythological figure, description of myths, characteristics of member stars, and prominent deep sky objects. These charts will serve both the naked eye and binocular observer well. I especially enjoy Wil Tirion's celestial cartography; he seems to enjoy a virtual monopoly in this area.

The beginning of the book presents a series of seasonal star maps, "Sky Tours," which display seasonal views in four directions (NW, NE, SE, SW) and offer the megascopic display of constellations in juxtaposition with their neighbors. Once one constellation is learned, one may proceed and learn its adjacent neighbors. Eventually, after the span of one year, one may witness the entire sequence of seasonal offerings.

The book's introduction is adequate, it generally stays within the naked eye milieu except for some diversions into modern astronomy such as "stellar evolution." Also, the introduction quickly jumps into a discussion of precession which may be inappropriate for beginning observers. I remember the late George Lovi's opinion that "Precession ordinarily shouldn't be introduced until college" (Sky & Telescope, October 1991). He believed that an abstract idea such as precession, when introduced inappropriately, could confuse more than enlighten. Such distractions lead to the formation of misconceptions. Lovi's opinion falls with the Constructivist paradigm. For example, when students are told of Earth's elliptical orbit they continue in their reasoning to conclude that Earth's varying distance from the Sun is the primary cause of Earth's seasons.

The Audubon guide is a direct descendent of William Tyler Olcott's "Field Book of the Skies." From the beginning of this century, this successful book went through umpteen editions and can be found in most libraries. I heartily recommend Olcott for the astronomer with an interest in star lore and astronomical history.

COMET COMMENTS (09-07-95)

by Don Machholz

C/1995 Q1 (Bradfield): William Bradfield of Australia discovered this, his 17th comet, on the evening of August 17. Bradfield found it with his 6" refractor. Then at magnitude 6, the comet was closest to the sun (0.44 AU) on Aug. 31. It will emerge into our northern morning sky in late September.

Comet Hale-Bopp: This comet continues to slowly brighten in our southern evening sky. The hope is that this comet will become quite bright in late 1996 and early 1997. The Northern Hemisphere is favored for this comet. With ahighly-inclined orbit, Comet Hale-Bopp crosses northward through the earth's plane at 5.0 AU from the Sun (mid-March 1996y, then descends through the plane (mid-May, 1997) at about 1.12 AU. By time we reach that point the comet will be long gone, and there is no chance of it hitting us.

EPHEMERIDES

C/1995 Q1 (BRADFIELD)					1994 01 (HALE-BOPP)				
DATE	R.A.(2000)	DEC	EL	SKY MAG	DATE	R.A.(2000)	DEC	EL	SKY MAG
09-30	11h10.7m	+21d06m	30d	M 8.2	09-30	18h16.2m	-29d20m	87d	E 10.3
10-05	11h10.3m	+24d16m	37d	M 8.6	10-05	18h16.3m	-29d06m	82d	E 10.3
10-10	11h10.0m	+27d32m	43d	M 9.0	10-10	18h16.7m	-28d52m	77d	E 10.2
10-15	11h09.6m	+30d59m	50d	M 9.3	10-15	18h17.4m	-28d38m	72d	E 10.2
10-20	11h08.9m	+34d40m	57d	M 9.6	10-20	18h18.3m	-28d25m	68d	E 10.2
10-25	11h07.7m	+38d40m	64d	M 9.8	10-25	18h19.5m	-28d11m	63d	E 10.2
10-30	11h05.6m	+43d02m	72d	M 10.0	10-30	18h21.0m	-27d58m	63d	E 10.1
11-04	11h02.1m	+47d48m	79d	M 10.2	11-04	18h22.6m	-27d45m	54d	E 10.1

SKY & TEL. NEWS BULLETINS

from the editors of SKY & TELESCOPE magazine

TRITON OCCULTATION
Neptune's giant moon Triton occulted an obscure 13th-magnitude star on the morning of August 14th (UT), and successful sightings are filtering in from several sites — including the Kuiper Airborne Observatory and NASA's Infrared Telescope Facility (IRTF) on Mauna Kea. Midway through the event the IRTF recorded a "central flash" — a refraction effect due to the moon's thin atmosphere. Astronomers expect to learn much more about Triton's atmosphere once their data is fully analyzed. Also, the occulted star turns out to be a binary.

HOW OLD IS THE UNIVERSE?
There's new evidence that something might be amiss with cosmologists' standard view of the universe. In the September 7th issue of NATURE, a team of astronomers led by Nial Tanvir of Cambridge University reports new Hubble Space Telescope observations of Cepheid variable stars in M96, a galaxy in the constellation Leo. Based on the stars' brightnesses and pulsation periods, the team concludes that M96 is 38 million light-years away. This in turn provides a baseline for gauging how far it is to the more distant Virgo Cluster of galaxies. Folded together with their recession velocities, these distances suggest that the universe could not be more than 9 to 12 billion years old. The conundrum is that some stars are known to be considerably older. But Hubble's intergalactic distance survey is far from over, and many more such measurements remain to be taken.

NOVA CASSIOPEIAE 1995
A nova was discovered on August 24th by Japanese observer Minoru Yamamoto. It's in the constellation Cassiopeia, at right ascension 1h 5.1m, declination +54d 2'. Nova Cas 1995 was magnitude 9.0 about a week ago, but predisvoery images show that it was no brighter than magnitude 12.5 on August 1st.

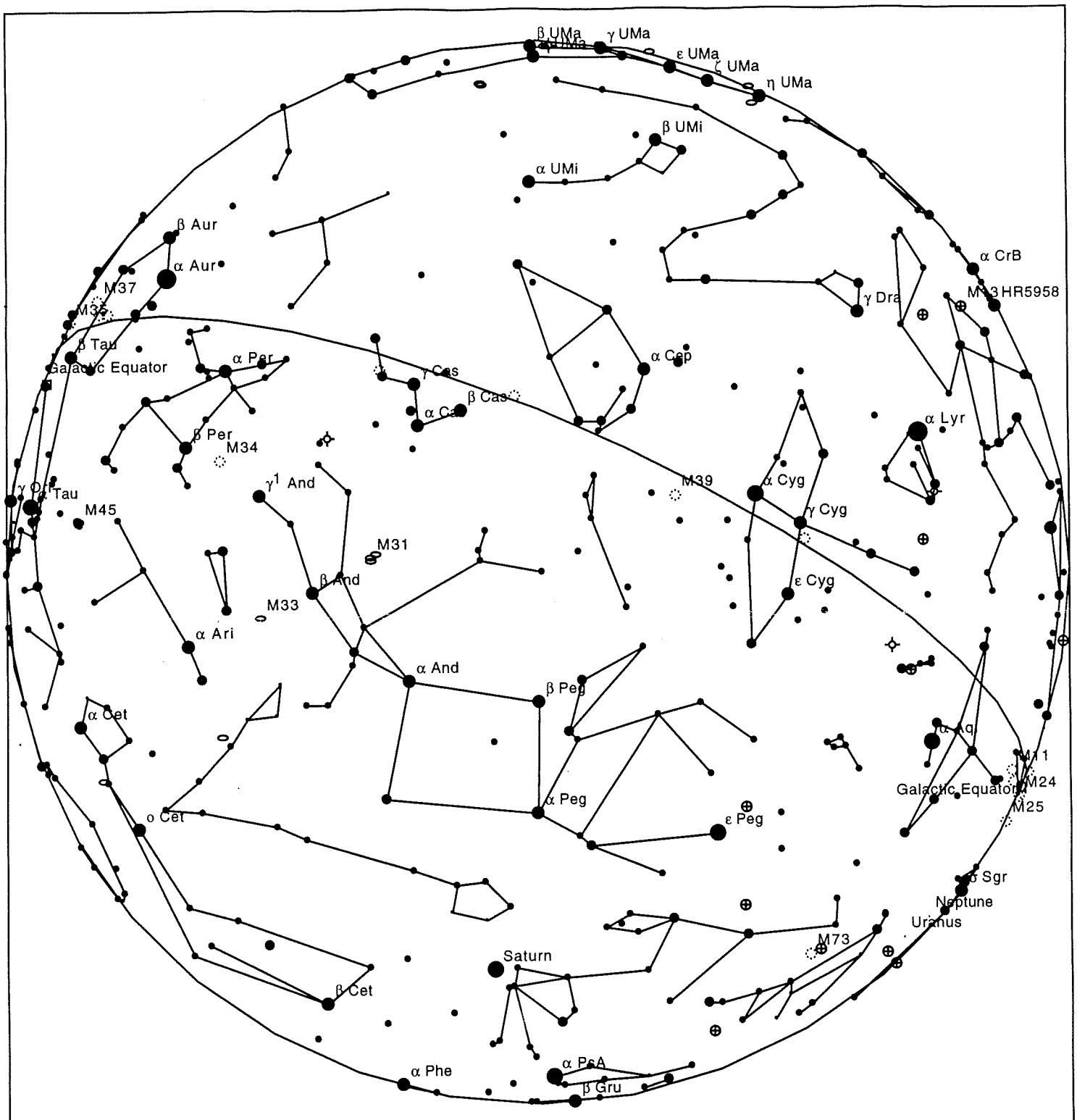
NEW U.S. CRATERS
A conference of planetary geologists in Washington, D.C., found out that having a meeting there probably wouldn't have been a good idea 35 million years ago. That's when a 1-km-wide object slammed into what is now the lower Chesapeake Bay, punching through shallow ocean to make a huge crater roughly 85 km across, create a massive tsunami, and devastate that entire section of the East Coast. The crater has been suspected for several years, but new analyses of drill cores show that rocks in the region were severely shocked, a sure sign of impact. The geologists also learned of another new crater, this one some 15 km across and buried off the coast of central New Jersey. According to geologist Wylie Poag, the two craters may have been created at the same time.

COMET DE VICO RECOVERED
Three Japanese amateurs have independently discovered a comet in the constellation Hydra. On September 17, Yuji Nakamura, Masaaki Tanaka, and Shougo Utsunomiya were each scanning with giant binoculars when they noticed a 7th-magnitude blur. They could see only a diffuse coma, but a CCD image by T. Kojima with a 10-inch reflector shows a "kinked tail" extending westward more than 0.4 degree. The comet is moving about 1.4 degrees per day toward northeast. According to dynamicist Daniel Green, this object appears to be the long-lost Comet De Vico, which has a 74-year orbit but was last seen in 1846. Green calculates that the comet will reach perihelion on October 6 just inside the orbit of Venus, and it should brighten to perhaps 5th magnitude but remain low in the predawn eastern sky.

COMET de VICO DELIVERS
Comet de Vico is making a fine showing in the predawn sky. When Richard Didick observed it on the 28th, its coma looked extremely condensed, near 5th magnitude, with a tail extending at least 1.5 degrees to the west. Images show the tail to be rather complex, with multiple strands. This week Comet de Vico will be cruising across the constellation Leo, and on the morning of October 1st you'll find it just 1 degree west of Regulus.

COMET BRADFIELD CLIMBS
Another interloper, Comet Bradfield, is emerging gradually from the predawn glare as it too heads through eastern Leo, moving due north. In fact, on October 5th Bradfield will pass just 5 deg north of Comet de Vico, putting them both in the same binocular field. Get those cameras ready!

OCTOBER'S SKIES



Viewed from:	Local Time:	Field of View: 180° 00' 00"	Stars:	5.5	4.5	3.5	2.5	1.5	0.5	Deep Sky Objects:
Dearborn	22:59:60	R.A.(2000.0): 23h 04m 32.3s	Single:	·	•	•	●	●	●	Open Glob Diff Plan Gal
83° 17' 00" W	1995/10/15	Dec.(2000.0): +42° 21' 60"	Multiple:	·	•	•	●	●	●	⁘ ⊕ □ ✧ ⬭
42° 22' 00" N	JD 2450006.63	Spherical projection	Variable:	·	•	•	●	●	●	

STAR TRAK FOR OCTOBER 1995

by Hal Kibbey of Indiana University

BLOOMINGTON, Ind.—The Hunter's Moon and the Orionid meteor shower will both happen during October. Fortunately they will happen at opposite ends of the month, according to Indiana University astronomers. The Hunter's Moon is the first full moon after the Harvest Moon (which is the full moon nearest the September equinox). In both cases, the full moon seems to appear soon after sunset for several evenings in a row, because the time between successive moonrises is about 20 minutes less than usual. This provides enough light for farmers and hunters to continue their activities in the fields after sunset.

This year the Hunter's Moon will be Oct. 8, and the Orionid meteor shower will peak on the night of Oct. 21-22. The Orionids may be the best shower of the year because of the moon. Normally the Orionids rank third after the Perseids of August and the Geminids of December, but this year both of those showers are spoiled by bright moonlight, which washes out the fainter meteors. The Orionids will peak just two days before the new moon, when there will be no moonlight to interfere. There should be about 25 meteors per hour in the early morning hours of Oct. 22 if the sky is clear. The shower will extend from about Oct. 16 through Oct. 27.

Start watching for meteors after midnight, when the planet will rotate into the particle stream from which the meteors come. The meteors may be in any part of the sky, but usually it's best to look about halfway between the horizon and straight overhead. Get away from city lights if you can, and try to find a site that gives a clear view of most of the sky. Be sure to dress warmly, and bring along a blanket or sleeping bag. A reclining lawn chair makes meteor watching more comfortable but also makes it easier to fall asleep. The Orionid meteors come from dust particles that once were part of Halley's Comet. When Earth moves through the comet's orbit, the particles that were shed by the comet and left behind in space collide with our atmosphere at about 145,000 miles per hour and are quickly burned up by the sudden friction. The intense heat makes the air molecules around a particle glow brightly for an instant, and we see a meteor.

Mercury will be out of sight during the first part of the month as it passes between Earth and the sun on Oct. 4-5. Then the little planet will make its best appearance of 1995 before sunrise, beginning in the second week and reaching its highest point on Oct. 20. The pinpoint of white light will be bright enough to spot easily with binoculars about a half hour before sunrise if you have a clear view of the eastern horizon. Look slightly to the right of east. When you find Mercury with binoculars, try to see it without them. By the end of the month Mercury will be dropping back toward the horizon, and it will disappear into the solar glare during the first week of November.

Venus will finally reappear in the evening sky during October, though it will be very low in the west after sunset all month. Only the brightness of Venus will enable you to see it so close to the horizon. By the end of the month it will set almost an hour after sunset. To the upper left of Venus will be Mars, a pale orange compared with the bright white of Venus. Mars is now almost on the far side of the sun from us, so it appears smaller and fainter than usual. Mars will pass through the constellation Scorpio during midmonth, approaching the bright orange star Antares on its left. The name Antares is from a Greek phrase meaning "rival of Ares." Ares was the Greek name for the god of war which the Romans named Mars. In this encounter, Antares will outshine its rival.

To the upper left of Mars will be brilliant white Jupiter, brighter than either Mars or Venus. The three planets will draw much closer together by the middle of November, with Venus rising to meet the other two. Saturn will be alone in the east-southeast at sunset, a bright yellow object in a part of the sky that otherwise has only faint stars. Saturn will drift across the southern sky during the night, its rings still tilted almost edgewise to Earth so they appear as a bright line in a telescope.

A total eclipse of the sun will occur in the Southern Hemisphere on Oct. 24, beginning at local sunrise in central Iran and moving eastward across parts of Afghanistan, Pakistan, India, Bangladesh, Myanmar, Thailand, Cambodia and Vietnam before ending in the southwestern Pacific Ocean. Totality will last only about 15 seconds in Iran, gradually increasing to a minute and a half in India and more than two minutes by the time the moon's shadow reaches the Pacific. Most of the rest of Asia and northern Australia will see a partial solar eclipse on Oct. 24. ✪

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