

OBSERVER

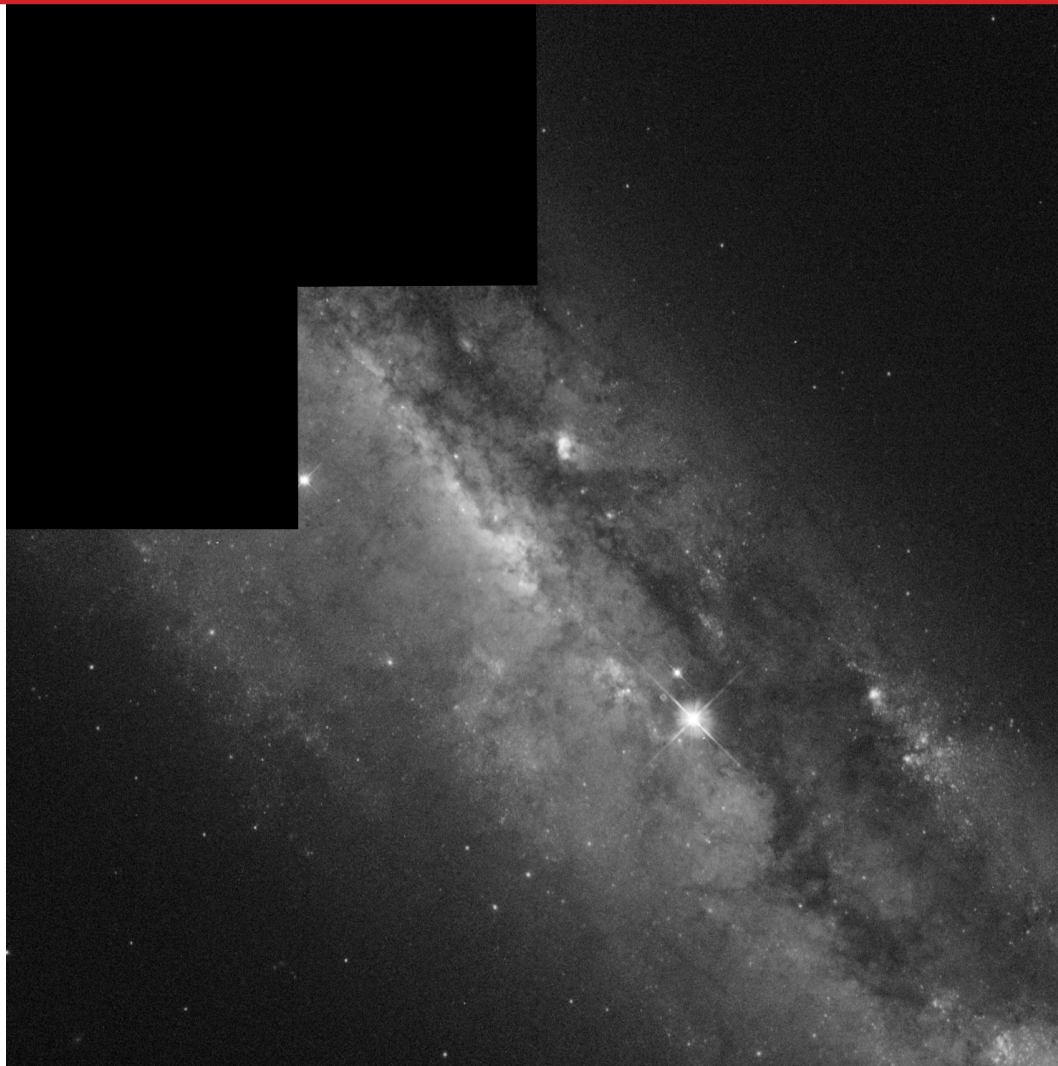


Image Credit: NASA, ESA, STScI and G. Illingworth (University of California, Santa Cruz)

Hubble Space Telescope image of the spiral galaxy M 108, in Ursa Major, one of the targets in "April Skies." The image was captured with a single filter, and so is naturally rendered in black-and-white.

APRIL SKIES

The Solar System

Mercury begins April lost in sunlight, as the planet is at inferior conjunction (lined up between the Sun and the Earth) on April 1st. As April progresses, Mercury swings eastward, becoming a pre-dawn object, but even at its best, toward the end of the month, it will remain low on the horizon.

We saw **Venus** in full-on sunlight last month, about 98% illuminated, from our point of view—and at the start of April, the view is similar—careful observers might discern a “slightly less than full” disk. By month’s end, the brilliant, -3.9 -magnitude planet will appear clearly gibbous and slightly

by Zachary Singer

larger in your eyepiece.

Mars remains a target for the wee hours, only 6° up at 3AM in early April. However, the planet’s disk, as seen from Earth, grows noticeably larger this month, to about 11”, and larger still, to 15”, by the end of May. So even if Mars isn’t big news just yet, detail on the Martian surface should begin to appear sometime next month.

In the meantime, weather permitting, we’ll be treated to a beautiful conjunction with Saturn (and M22, near the top of Sagittarius’s “teapot”) on the mornings of April 1st, 2nd, and 3rd—closest on the the 2nd. On these mornings, the planets lie less than 1½° apart;

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Sky Calendar

- 8 Last-Quarter Moon
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Society Directory

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PRESIDENT'S MESSAGE

by Ron Hranac

The "Ideal" Telescope

As members of Denver Astronomical Society, we're often seen as experts when it comes to astronomy-related topics, and that includes questions about the best telescopes and accessories. Providing guidance on selecting a telescope—especially a first-time telescope—is a lot more difficult than it might first seem. Indeed, there is a whole lot of "it depends" that comes into play. Start with a list of basic questions: How much money has the "household finance department" approved? What will the telescope be used to observe? Will the 'scope be used for visual observing only, or is astrophotography part of the plans? Does the 'scope need to be portable, or will it be used in a home observatory? And so on...

If we could make up a wish list, the "ideal" 'scope would be a contradiction: It would have to collect as much light as possible with a very large aperture (aperture is the diameter of the main lens or mirror, and more aperture generally means better detail as well as the ability to observe dimmer objects). The mount would be very heavy-duty (that is, *heavy*) to minimize image shake. Both of these qualities would make a 'scope much bulkier, but

as telescope users, we also want a 'scope and a mount that could be easily carried by one person. Similarly, the glass in a big 'scope takes longer to cool down (so that its temperature matches that of the outside air—images are a bit blurry until then), but we want a 'scope that's ready to go, *right now*. The 'scope and its motorized, battery-powered mount would slew to the desired object after a simple voice command and track it all night without any follow-up user tweaking needed. But motorized mounts add weight, as does a battery—and then you have to align the mount, get the computer working... And of course, our fantasy 'scope would cost no more than a couple hundred bucks.

Since such a 'scope doesn't exist, now what? It's been said that the best telescope is one that gets used. All too often, someone will spend a lot of money on *too much* of a first-time telescope, only to find that it's too big, too heavy, too difficult to set up, and too hard to use. The 'scope ends up sitting in a closet or basement, collecting dust. At the other end of the spectrum, someone will buy one of those skimpy, small-aperture department-store-

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DAS SCHEDULE

April 2018

- | | |
|------------|---|
| 6 | E-Board Meeting—At DU's Historic Chamberlin Observatory, 7:30 PM.
All members welcome. |
| 7 | DAS Member In-Reach—At DU's Chamberlin Observatory, 7:00 PM |
| 14 | Dark Sky Weekend—EGK Dark Site & Brooks Observatory |
| 21 | Open House—DU's Historic Chamberlin Observatory—Starts at 7:30 PM |
| 27 | DAS General Meeting—DU's Olin Hall, Rm. 105—Starts at 7:30 PM |
| (May 2018) | |
| 4 | E-Board Meeting—At DU's Historic Chamberlin Observatory, 7:30 PM.
All members welcome. |
| 12 | Dark Sky Weekend—EGK Dark Site & Brooks Observatory |

During Open House, volunteer members of the DAS bring their telescopes to the Chamberlin Observatory's front (south) lawn, so the public can enjoy views of the stars and planets, try out different telescope designs, and get advice from DAS members. The Observatory is open, too (costs listed below), and its historic 20-inch telescope is open for observing with no reservations necessary.

Open House costs (non-members): If the skies are clear, \$2/person (\$5/family), \$1/person in inclement weather. DU students with ID, and DAS members free.

Public Nights feature a presentation on astronomical subjects and a small-group observing session on the historic 20-inch telescope (weather permitting), at Chamberlin Observatory on Tuesday and Thursday evenings (except holidays), beginning at the following times:

March 10 - September 30 at 8:30 PM

October 1 - March 9 at 7:30 PM

Public Night costs (non-members): \$4/adult, \$3/child and students with ID. DAS members and DU students with ID: free.

Members of the public (non-DAS/DU, as above), please make reservations via our website (www.denverastro.org) or call (303) 871-5172.

President's Message

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grade telescopes that nonetheless advertises 500 power on the box, and find that the mount is wobbly, the telescope's image quality is awful, and the whole thing is poorly made. That, too, ends up sitting unused in a closet or the basement, collecting dust.

What we're looking for, then, is a compromise: Something big enough for *your* purposes, delivering the best-possible image quality while trading off with a realistic ease of use and cost. The "best" telescope will always be something that's best optimized for what *you* want to see, and your ideal 'scope may not be the same one as mine or the next observer's.

When it comes to the type of 'scope, there are several options, each with pros and cons. Refractors, reflectors, and compound optic (aka catadioptric) round out the three general families of telescopes. Whatever the 'scope, the importance of a sturdy mount can't be overemphasized.

Some companies make small table-top telescopes, usually reflectors in the roughly four-inch-aperture class. Some of these have received good reviews, but a table or other support is necessary.

Refractors are especially nice for lunar and planetary observing, and some models can provide nice wide-field views. They're usually easy to set up and require minimal cooling time. The downside is aperture; common sizes range merely from a little over two inches to five inches. Larger apertures, especially in the high-end apochromat refractors, can get really expensive, really fast.

A good all-around telescope is a five- to eight-inch-aperture compound optic such as a Schmidt-Cassegrain (SCT) or Maksutov-Cassegrain (Mak or Mak-Cass), but bigger ones might be a bit much for some people to use as a beginner's scope.

Another good choice is what is commonly referred to as a Dob. The 'scope itself is usually a Newtonian reflector installed on a Dobsonian mount. These are available from several companies; the simpler models can be relatively inexpensive and offer larger apertures for the same money by sacrificing (arguable) luxuries like motorized mounts.

Binoculars are also a good entry-level choice. Binoculars can provide stunning wide-field views (especially from a dark sky location). Several companies have decent and affordable astronomy binoculars available, but the bigger ones—say, 10x70 or 10x80 (where the first number is the magnification and the second number is the aperture diameter in millimeters)—really need a small tripod for support. Without that support, it's difficult to hold the binoculars steady after just a few short minutes. An alternative is image-stabilized binoculars, but they tend to be rather pricey.

Not long ago, someone left a message on my home's voicemail, asking for help choosing a telescope. After a little telephone tag, we finally were able to chat. I suggested that the caller stop by one of our monthly Open Houses at DU's historic Chamberlin Observatory, to take a peek through the 'scopes members have set up on the park lawn and get an idea about using various makes, models, and types. I also suggested that he take advantage of the Open House's Learner's Land, where he could drive a 'scope on his own. After a few minutes of discussing the pros and cons of various designs, he sounded like he was leaning toward a six- to eight-inch Dob. Good choice!



ABOUT THE DENVER ASTRONOMICAL SOCIETY

Membership in the Denver Astronomical Society is open to anyone wishing to join. The DAS provides trained volunteers who host educational and public outreach events at the University of Denver's Historic Chamberlin Observatory, which the DAS helped place on the National Register of Historic Places. First light at Chamberlin in 1894 was a public night of viewing, a tradition the DAS has helped maintain since its founding in 1952.

The DAS's mission is to provide its members a forum for increasing and sharing their knowledge of astronomy, to promote astronomical education to the public, and to preserve DU's Historic Chamberlin Observatory and its telescope in cooperation with the University of Denver. The DAS is a long-time member in good standing of the Astronomical League and the International

Dark Sky Association.

The DAS is a 501 (c)(3) tax-exempt corporation and has established three tax-deductible funds: the Van Nattan-Hansen Scholarship Fund, the DAS General Fund, and the Edmund G. Kline Dark Site Fund.

*****JOIN US!** More information about DAS activities and membership benefits is available on the DAS website at www.denverastro.org.



ASTRO UPDATE

Selected Summaries of Space News

by Don Lynn

Stephen Hawking Dies at Age 76

Dr. Stephen Hawking has died, after becoming perhaps the most recognizable figure in physics and cosmology. For many years, he held the same professorship at Cambridge that was once held by Isaac Newton. Hawking's scientific work included much theory on singularities and black holes. His most famous result is that quantum physics implies that radiation should slowly leak out of black holes, a process dubbed Hawking Radiation. This was expected to earn for him a Nobel Prize whenever Hawking Radiation was detected, but such detection remains unachieved.

Hawking was diagnosed with ALS 54 years ago; usually, the disease is fatal within a few years. It confined him to a wheelchair for much of his life. When he lost the ability to speak, a computer system was developed that allowed him to write and speak. Hawking was able to control it for years with one hand, but as his condition deteriorated, the system had to be adapted to respond to his facial movements.

Dr. Hawking has been quoted as saying that his sense of humor helped him work through his disability. That humor showed up in guest appearances on shows that included *The Simpsons* and *The Big Bang Theory*.

In 1988, Hawking published a book, *A Brief History of Time*, which explained cosmology in terms the public could understand, and it became a record-setting best seller. He said he wrote it to be able to pay for his daughter's schooling. The book was followed over the years by many more, some coauthored with various scientists, authors, and his daughter. The world has lost a great scientist and icon of courage in the face of disability.

First Stars

Scientists using a new small radio telescope in Australia have for the first time detected evidence of the earliest stars in the Universe. The observations, made in lower-frequency radio than previous attempts, showed spectral lines of hydrogen indicating that it had been ionized by the ultraviolet light of stars. The expansion of the Universe since the original light was emitted stretched the signal out enough to become 78 megahertz radio waves.

The distance, and therefore the look-back time, indicates this was sooner after the Big Bang (only 180 million years after it) than any other detection of gas that was similarly ionized. The radio signal was stronger than expected, which means that the hydrogen was cooler than theory predicts, at about half the expected temperature. One possible explanation for this is that dark matter interacted with the hydrogen somewhat more strongly than expected, which would cool the gas. More observations and experiments are needed to determine why the radio signal was so strong.

Hubble Constant

Astronomers using the Hubble Space Telescope have completed a study designed to add more precision to the measure of the Hubble Constant, the rate at which the Universe is expanding. The increased precision comes from expanding the number and distance of observed Cepheid variables—Cepheids provide precise distance measurements to galaxies close enough for Hubble to see

individual stars. The Hubble Telescope's result for the Constant is 73, and it is estimated to have no more than 2.3% error.

That does not agree well with the calculation of the Constant made from Planck Space Telescope data, which came up with 67 and is believed to be within 3% of correct. (The new result also does not agree with last month's determination of the Hubble Constant by the Dark Energy Survey team.) The Planck result depends on properties of the Cosmic Microwave Background (CMB), which is light that was emitted just 370,000 years after the Big Bang. The Planck calculation takes into account the *cumulative* effects on the CMB of expansion of the Universe, ordinary matter, dark matter, and dark energy.

Interestingly, the new measurement does agree quite well with the latest result from studying Type Ia supernovas. The supernova result depends more heavily on *current* conditions of the Universe. The Hubble's result agrees so well with the supernova result that theorists are looking for something that was overlooked in the Planck calculation. The first guesses at this are that there is another (undiscovered) kind of neutrino, or that dark matter interacts with ordinary matter or with light somewhat differently than theory suggests.

Supernova Imaged Early

An amateur astronomer in Argentina did something no one else has ever done: he took a series of images of a supernova during the first hour of its explosion. He was testing a new camera on his 16-inch telescope while aimed at the galaxy NGC 613, and noticed a star not visible on the first images he took but brightening on succeeding images. Professional astronomers are using the images to learn more about the early behavior of supernovas. Theory and subsequent study showed that the star had an initial mass about 20 times that of the Sun, and had lost $\frac{3}{4}$ of its mass, probably to a companion star, before collapsing in a Type IIb supernova.

Halo Stars

Our Milky Way galaxy is surrounded by a huge but sparsely populated halo of stars. It has long been thought that most of the stars in that halo are ones that were captured from small galaxies that collided with the Milky Way. However, a new spectroscopic study of 15 halo stars show that they originated in the disk of the Milky Way, not in other galaxies. This was determined from detailed chemical analyses of the stars.

Intriguingly, computer simulations show that although collisions of small galaxies didn't contribute stars directly, they were still involved. The collisions appear to have set up waves in the disk of the Milky Way, and those waves threw stars from our galaxy's disk out into the halo. Further work is planned to measure more halo stars (including some farther away from the disk), and to determine the stars' ages and masses.

Unusual Binary Star Comes to Life

Integral (X-ray space telescope) has observed a particular binary star for 15 years and just saw for the first time an X-ray burst from the neutron star in that binary. Astronomers believe that the

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DAS NEWS

April Member In-Reach

Our In-Reach on April 7th, at Chamberlin Observatory from 7 to 10 PM, presents a talk by Digby Kirby on telescope basics—what you need to know to set up and effectively use your first telescope or a loaner 'scope furnished by the DAS. We'll also have tips on learning the night sky and planning an observing session, with "hands-on" opportunities on the lawn after the talk is over. (We'll include a discussion of recommended books and apps, too.)

After that, Jack Eastman offers "Beyond the Basics," for those who want to delve into more technical aspects of optics and all things to do with telescopes.

Finally, we'll give a preview of upcoming In-Reach talks and programs to give you an idea of what's in store in the coming months. For further information, contact Digby Kirby, DAS New Member Ambassador, odigby@gmail.com, (970) 301-2287.

Volunteer Opportunities

April 4th, 2018, start ~ 8:00 PM: Star Party, Carson Elementary (3rd grade), Denver, CO.

April 5th, 2018, 3:00-6:00 PM: Spring Resource Fair (table, kids' activities, or solar scope). APS Professional Learning and Conference Center, 15771 E. First Ave., Aurora, CO.

April 8th, 2018, 8:00 AM-2:00 PM: table or solar scope, Frank Shorter Race4Kid's Health, Broomfield, CO.

April 14th, 2018, 8:00 AM-1:00 PM: March for Science (table, solar scopes, or make a sign and march), Civic Center Park.

To volunteer, please contact July Candia:
external@denverastro.org
—and thanks!

April General Meeting

Join us at the General Meeting at DU's Olin Hall, Room 105, on Friday, April 27th, at 7:30 PM, for a presentation by Dr. Hal Levison. Dr. Levison is the Principal Investigator of NASA's upcoming Lucy mission to study the Trojan asteroids.

Lucy, to be launched in 2021, is one of the latest NASA Discovery-class missions and will send a uniquely configured spacecraft to investigate six primitive bodies near both the L4 and L5 Lagrange points with Jupiter—the Jupiter Trojans, where planetesimals from the outer planetary

system have been preserved since early in Solar System history. All of the stable populations of the Solar System have been visited by spacecraft, except for the Trojans. The Lucy mission will fill in that gap by extensively studying all the recognized taxonomic classes of Jupiter Trojans. Owing to the critical role they play in constraining models of the formation and evolution of the Solar System, and the belief that they provide a fossil record of planet formation, Trojans have been a high priority for space missions



Dr. Levison and a Lucy mockup.

for over a decade.

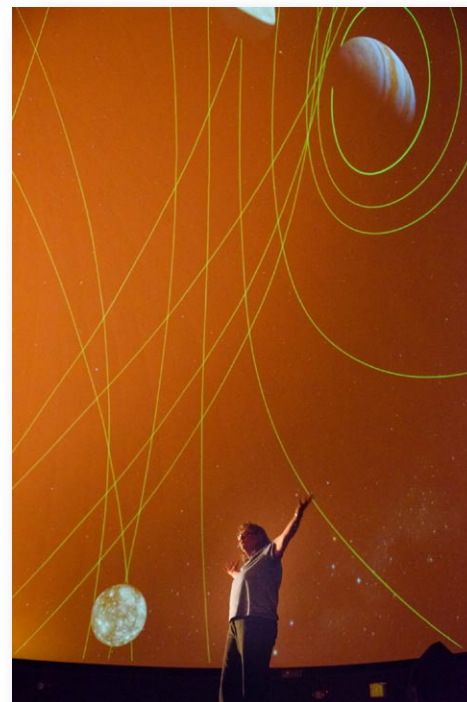
A reception following the meeting will be held at DU's Historic Chamberlin Observatory. Coffee and light refreshments will be served.

DAS Goes to the Planetarium

DAS Members took a field trip on March 18th to the Fiske Planetarium in Boulder, to see Dr. Fran Bagenal's presentation on the latest data from Jupiter.



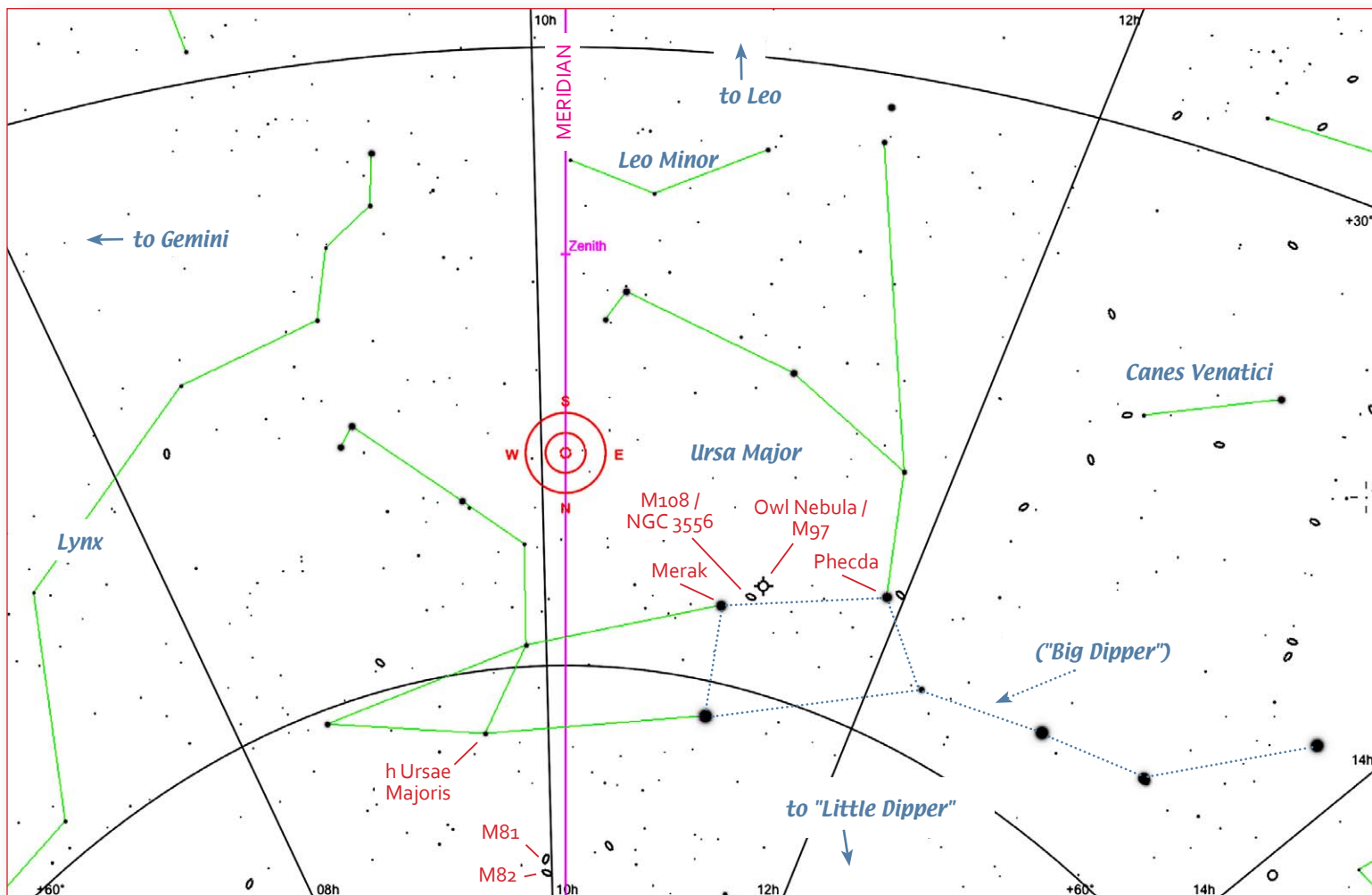
Left: DASers, including those in foreground, made up much of the crowd for Dr. Bagenal's detailed presentation.



Right: Dr. Bagenal makes her point.

Photos (2): © Z. Singer





Looking north in Denver's sky at 9:30 PM in mid-April. The constellation Ursa Major, the Great Bear, appears upside-down here, compared to most star charts, because those charts assume a south-viewing observer. Note the "Big Dipper," delineated with dots; this figure is usually more familiar to beginners, and makes up part of Ursa Major's "Bear." The Dipper's "handle," for example, can also be imagined as the Bear's "tail," and the Dipper's "cup" can be thought of as the rear part of the Bear's "body." (The Bear's "rear legs" can be seen arcing upward from the star Phecda, and the "front legs" arc toward the constellation Lynx, at top left. The Owl Nebula, near center, would be about 70° above the northern horizon. (Telrad circles included for reference.)

Object positions, constellation and meridian lines charted in SkySafari, and then enhanced.

April Skies *Continued from Page 1*

they'll be about 22° above the southeastern horizon at 5AM. A recent (late-March) view of the pair, when they were still 4° apart, was already very striking. Similarly, if we get clouded out, *the pair will remain interesting for days afterward.*

Jupiter is in an increasingly good position for observations—it rises just after 10:30 PM in early April, and more than two hours earlier by month's end. In practice, that puts Jupiter high enough for a reasonably sharp image by around 1AM as April begins, and before 11PM a month later. (If a 1AM observation don't bother you though, the planet sits near the Meridian at that hour, 33° above the southern horizon, at month's end—the higher altitude should provide a cleaner image.) Though Jupiter's apparent diameter will grow only slightly larger this month, observing times will get better and better through the summer.

Saturn, like Mars, is still a target for insomniacs or early-rising observers. In spite of that, the ringed planet is high enough after 4AM to provide reasonable image quality in telescopes, so those of you getting up early before work (or doing all-nighters at the dark

site) are in luck. As with Jupiter, conditions will get even better as the season progresses.

On April 1st, **Uranus** is at superior conjunction (roughly along a line with the Earth and Sun, and sitting on the opposite side of the Sun, away from us). That means that the planet is hidden in solar glare for now, but the planet will reemerge as a pre-dawn object later this spring.

Neptune starts April hidden in the light of dawn, but becomes visible, low in the east in morning twilight, towards the end of the month.

Stars and Deep Sky

This month, we take another look into the constellation Ursa Major, the Great Bear. If beginners haven't heard of this constellation, they're still likely to be familiar with a part of it—the "Big Dipper." As it happens, we'll be looking into the Dipper area, so though we'll be talking about Ursa Major, the stars we use as guideposts won't be hard to find.

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April Skies

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Our first object is the **Owl Nebula, or M97, at 11h 16m, +54° 55'**. (On some charts, you may also see it listed as **NGC 3587**.) It's a so-called "planetary nebula," a class of nebulae named for their resemblance to dim planets in a telescope eyepiece. The Owl features the round appearance common to many of these nebulae, but with a twist—two "eyes," visible in larger telescopes, that give the nebula its name.

Like other planetaries, the Owl is in reality an expanding gaseous structure, created as a dying star throws off its outer atmosphere. These structures can take different forms, and in the case of the Owl, astronomers believe it's shaped something like a cylinder or hourglass. In either case, imagine that shape made of glowing opalescent material, and that we're looking "upward," through its "bottom." From such a position, we'd see a single, roughly circular figure, perhaps with a "hole" in it, where less-dense areas send us less light. (This description also works very well to describe the Ring Nebula, M57, in Lyra, which looks like a glowing "donut;" astronomers know it's a double-lobed structure, as above.)

In the Owl's case, take your imagination one step further, and imagine that from our original viewpoint, we've moved to the side, and we're still looking "up" at it, but now from a position well off-center. Instead of one "hole" or "ring," we'd see *two*, (effectively, with one somewhat behind the other), and that is why we can see (or at least photograph) the Owl's famous eyes.

Sources suggest that these eyes might be visible in an 8-inch telescope equipped with a UHC filter, under clear dark skies. Realistically, the eyes may take a 10-inch, considering our often-imperfect conditions, but smaller apertures are at least *possible* using a filter on a very good night. (I also remember seeing the Owl from *suburban Denver* in my 12-inch Newtonian, albeit without the eyes.) With or without the eyes, the nebula is an interesting object, fairly large and dimming subtly at the outer edge—you shouldn't have any trouble out in the country with a 5- or 6-inch 'scope.

Interestingly, although astronomers are fairly certain about the Owl's *shape*, they are far from agreeing on its distance. Planetary nebulae generally are tough objects in this regard, but the Owl's distance estimates are quite wide-ranging, from somewhat over 1,000 light-years to as much as 12,000. (In contrast, the Ring Nebula is thought to be somewhere between 1,400 and 4,000 light-years away.) As a result, we can't be sure of the nebula's intrinsic brightness ("absolute magnitude"), because this factor is calculated directly from its distance and visual brightness.

To find M97, look for Merak, aka Beta (β) Ursae Majoris—it's the "bottom-right" star in the Dipper's cup *when you see the Dipper right-side-up*. Then look for h Ursae Majoris—often "h UMa" for short. It's the more unassuming, 3rd-magnitude star that makes up the Bear's shoulder (*see star chart*).

Center your Telrad on Merak, and then move it *away* from h Uma, until Merak rests on the outer, 4° Telrad circle. You're *close* now—just *nudge* your 'scope gently towards Phecda (Gamma [γ] Ursae Majoris), the "bottom-left" star in the Dipper's cup, and you should have the Owl in a low-power eyepiece field. If not, try again, or gently orbit that position. (The "nudge" should move your 'scope less than the width of the innermost, ½° Telrad circle—not very much at all.)

M97 has one more trick up its sleeve: It lies very nearly on the same line-of-sight as that of our next target, the **spiral galaxy M108 / NGC 3556**. (That means that M108's coordinates should be quite similar to M97's, and they *are*, at **11h 13m, +55° 35'**.) The two objects appear close enough together that a low-power, 1° telescopic field will include both objects, though admittedly at opposite edges. Even if your 'scope won't give you that wide of a field, M108 is a worthy target, and it's so close to where you're already observing the Owl, that it would be a shame to miss.

M108 is often described as a dimmer-looking version of M82, one of the famous pair of Bode Galaxies (the other is M81) that lies in another part of Ursa Major. Like M82, M108's dust and gas clouds can create a mottled appearance in an eyepiece—in 108's case, even in telescopes of moderate aperture.

That's where the similarities stop—M82 is a disturbed spiral galaxy, and "relatively close" to us, as galaxies go, at a distance of roughly 12 million light-years. Its mottling results from a significant gravitational interaction with M81, which greatly altered its internal structure. M108, on the other hand, is a more regular barred spiral, like our own Milky Way, lying more than three times farther from us than M82. 108's mottling comes mostly from being seen from a nearly edge-on point of view, which emphasizes the dust clouds that our vantage point causes us to look through.

M108's dimmer appearance comes from its greater distance—the absolute magnitude, or intrinsic brightness, of M108 is in about the same range as M82's. Still, M108 can be seen under country skies as a thin "wedge" shape, even in smaller instruments.

If you're starting off from M97, and you can manage a 1° or better field in your telescope, the easiest way to find M108 is to nudge your 'scope in the direction of Merak until M108 shows up—in that 1° view, the galaxy will appear near the opposite side, just before M97 exits the field.

Don't fret if you can't use that trick; finding M108 from scratch is straightforward, too. Center your Telrad on Merak and slide it along the line towards Phecda until Merak lies in-between the mid-sized (2°) Telrad circle and the outer (4°) one. A *slight* (¼°) perpendicular movement away from Ursa Minor (the "Little Dipper") will put M108 in your eyepiece. If it's easier for you, you can also think of the direction of movement as *towards* the constellation Leo, or towards Ursa Major's (the Bear's) "rear legs."

One quick note for Dobsonian-telescope users—as you'll see from this month's star chart, our targets lie very close to the zenith (i.e., they're almost straight up) at our stated time, making it tough to point your 'scope at them. If necessary, try going for this part of the sky an hour or so later, when it's in a more convenient spot. (You won't lose anything by doing so; you'll just find the Bear a little farther westward.)

—See you next month.



Astro Update*Continued from Page 4*

other star of the binary, a red giant, has dumped material onto the neutron star, causing the X-ray emissions. (There are only 10 known binary stars that are composed of a red giant and a neutron star.)

The binary is a strange one, in that binary stars should form at the same time, and yet the neutron star seems to be much younger than the red giant. One possible explanation is that the neutron star did not form the usual way, by collapse of a played-out massive star, but instead built up to a neutron-star-mass by having material dumped onto it by its companion red giant. This would take longer than the usual formation of a neutron star, thus accounting for the age discrepancy.

The length of time since the star transitioned into a neutron star is also a puzzle, since its magnetic field says it is young, but its spin rate says it is old. The dumping of material by the red giant may have changed the spin rate.

Binary Neutron Stars

A binary star consisting of 2 neutron stars has been discovered using the Arecibo radio telescope. The stars are so close that they orbit in just 1.88 *hours*, the shortest period of any known binary neutron stars. One of the pair is spinning every .017 seconds, fairly fast for a neutron star.

Such closely orbiting pairs emit gravitational waves, which cause their orbit to shrink, eventually forcing them to collide. In this pair's

case, this will happen in 46 million years. On that far-off day, the fast spin of one of the stars will amplify the gravitational waves, making the strongest such waves of any currently known neutron star pair. In the meantime, because of the extremes in this binary, it can serve as a gravitational laboratory, testing various effects of General Relativity.

Eccentric Exo-Planet

There are 116 confirmed exo-planets that orbit giant stars. The latest-discovered of these, dubbed HD 76920b, has the most eccentric (elongated) orbit. The planet has around four Jupiter masses and orbits its star in 415 Earth-days. Usually, eccentric planet orbits are caused by a companion star disturbing the orbit. But no companion star has been found in this case, so the next best explanation is that close encounters with other planets, probably early in the life of the planetary system, disturbed the planet into its eccentric orbit. The eccentricity is so extreme that the planet comes within four star radii of its host at the closest orbital point. Tidal forces and star expansion will engulf the planet in its star within about 100 million years.

