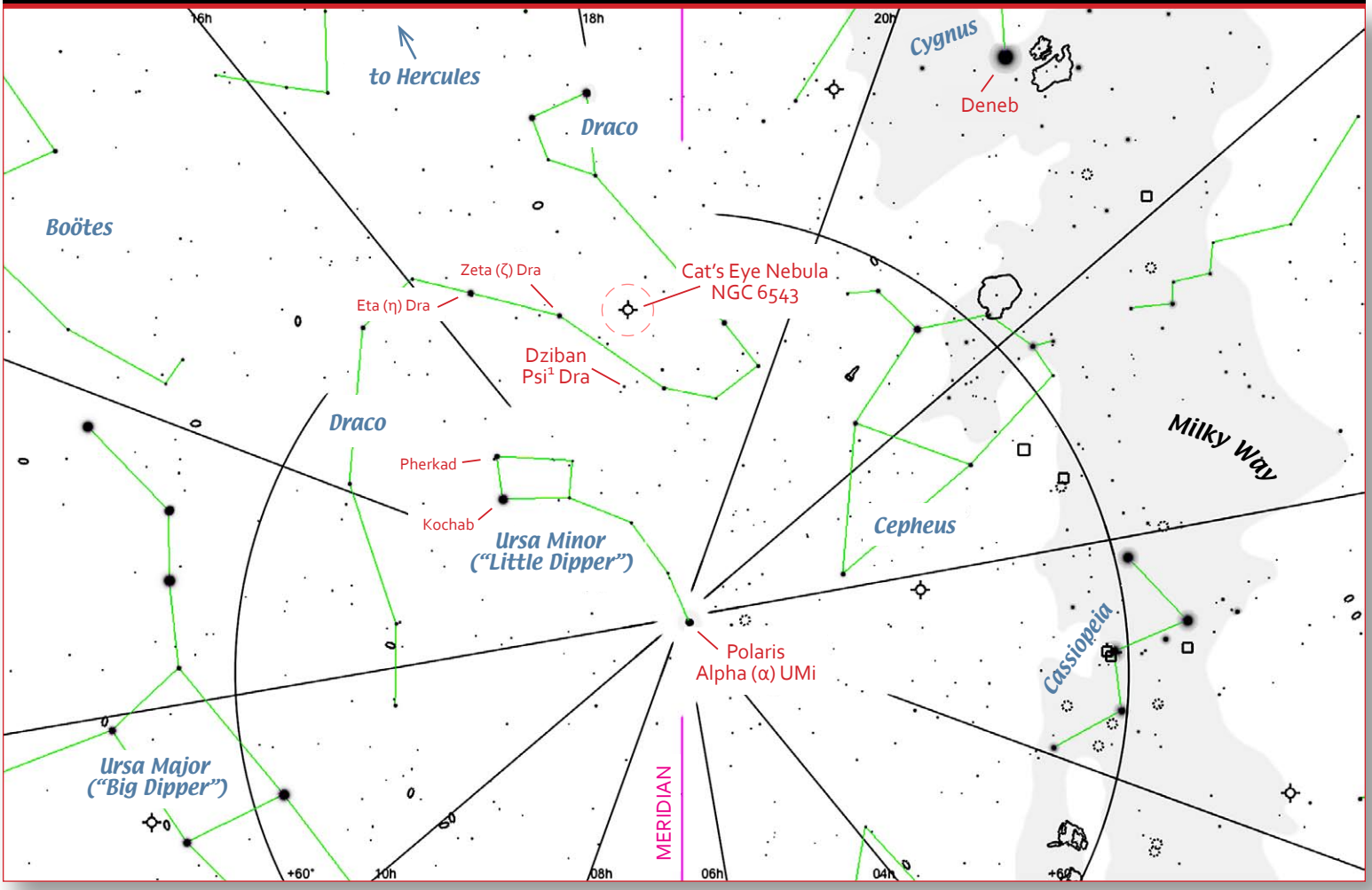
The Denver
OBSERVER
AUGUST 2017



Wide view, looking *due north* in Denver skies at 10:00 PM in mid-August; center of chart is roughly 50° above the horizon. Note that the orientations for most of the constellations shown are "upside-down" from traditional charts, which are generally drawn assuming a south-facing observer.

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

AUGUST SKIES

by Zachary Singer

The Solar System

Briefly: This will be a great month for Saturn! Look for it in the southwest after dark, gleaming above the constellation Scorpius.

This month, the BIG NEWS is the **total solar eclipse on the 21st, and I want to put across to everyone the *necessity for eye-safety during the eclipse's partial phases.* As of this writing, DAS still has a small supply of eclipse glasses—they're needed *at all times while viewing the Sun here in Denver*, and for all but one or two minutes where totality can be seen. Supplies of these glasses are becoming tight through other sources, so come to the Observatory while we have them.**

During totality, Venus, at mag. -4.0, will be obvious in the twilight sky and Mars should be visible about 8° west of the Sun. At magnitude 1.8, the red planet will be slightly dimmer than Regulus, which itself "should" be visible, a little over 1° from the Sun. Some sources have suggested binoculars for viewing this star, but ***I do not recommend it***—folks will be tempted to go filterless on their binoculars and totality will be over sooner than realized, creating a major risk. Jupiter will be low on the eastern horizon, and Mercury will be a dim 3.3-mag, 10° east of the Sun. (Its thin crescent is a tempting notion, but the time to find it will be short, and the same safety risks exist.)

Please see this month's "President's Message" for additional information and links about the eclipse.

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Sky Calendar

7	Full Moon
14	Last-Quarter Moon
21	New Moon
21	Solar Eclipse
29	First-Quarter Moon

In the Observer

The Observer is available in color PDF format from the DAS website: http://www.denverastro.org/das/denver-observer/

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PRESIDENT'S MESSAGE

by Ron Hranac

August's Total Solar Eclipse

The total solar eclipse of Monday, August 21st, 2017, is just about upon us. On that date, the Moon's umbral shadow will race from Oregon to South Carolina in a mere 94 minutes. The last total solar eclipse that was visible in the continental United States happened 38 years ago, and it has been 99 years since a total solar eclipse's path of totality crossed the U.S. from coast to coast similar to this year's. I think it's safe to say there's a lot of excitement and anticipation in the air.

Denver Astronomical Society has received several requests over the past few months asking if we are planning eclipse-day observing activities at DU's Chamberlin Observatory or other venues in or near Denver. The answer is no, because most of our members are planning to travel out-of-state to locations within the path of totality. Those who stay behind in the Denver Metro area will get to see a nice partial solar eclipse on the 21st (about 92 percent obscuration at maximum), but they won't experience a total eclipse. For that, one must be within the relatively narrow path of totality, which averages about 67 miles wide. NASA has a helpful interactive eclipse map on their web site. (Zoom in to any location on the map, click on that spot, and details about the eclipse at that location will pop up.) Here's a link to the map page: https://eclipse2017.nasa.gov/sites/default/files/interactive_map/index.html. There is also a great app written by the same folks who did NASA's interactive map, called "Totality" by Big Kid Science, available for free from the respective app stores for both Apple and Android platforms.

The "President's Message" in the June 2017 *Denver Observer* (https://www.denverastro.org/newsletters/june2017_denverobserver.pdf) includes a discussion about how to observe this month's eclipse. The PowerPoint slides I used for a presentation I did on the same topic, with assistance from fellow DAS member Sorin, at the July general membership meeting is available at https://www.denverastro.org/das/wp-content/uploads/2017/07/How-to-observe-2017-total-solar-eclipse2.pdf.

Safety

It has been said that a total solar eclipse is Mother Nature's most spectacular sight. But observing the Sun for any reason requires that safety be the top priority. The Sun is bright

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DAS SCHEDULE

August 2017

4	DAS General Meeting—DU's Olin Hall, Rm. 105—Starts at 7:30 PM
11	E-Board Meeting—At DU's Historic Chamberlin Observatory, 7:30 PM. All members welcome.
12	Member In-Reach—At EGK Dark Site & Brooks Observatory, 7:00 PM. (See page 3.)
19	Dark Sky Weekend—EGK Dark Site & Brooks Observatory
26	Open House—DU's Historic Chamberlin Observatory—Starts at 8:30 PM

(September 2017)

2	Member In-Reach: Roundtables, 7:00-9:00 PM (See page 3.)
8	DAS General Meeting—DU's Olin Hall, Rm. 105—Starts at 7:30 PM
15	E-Board Meeting—At DU's Historic Chamberlin Observatory, 7:30 PM. All members welcome.

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.

DAS NEWS

Volunteer Opportunities

Saturday, August 5, 2017, TBD: *Jeffco Planetarium, Lakewood.* They are deciding night observing vs. solar viewing.

Sunday, August 6, 2107, 10:00 AM-4:00 PM: *DMNS Free Eclipse Day, Denver.* DAS table and solar viewing.

Monday, August 7, 2017, 5:30-6:30 PM: *Eloise May Library, Denver (S. Parker Rd.).* Solar observing and eclipse info.

Tuesday, August 15, 2017, 6:30-8:00 PM. *Belmar Library, Lakewood.* Solar observing and eclipse info.

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

August General Meeting

On Friday, August 4th, at 7:30 PM, Dr. Jennifer Hoffman will present, "Shadows in Space: What We Learn from Eclipses, Occultations, and Transits."

Dr. Hoffman earned her Ph.D. in Astronomy from the University of Wisconsin-Madison in 2002 and held an NSF Astronomy & Astrophysics Postdoctoral Fellowship at UC Berkeley before joining the DU faculty in 2007. Her observational and computational research focuses on the connection between supernova explosions and their massive star progenitors, as illuminated by the circumstellar material surrounding both types of objects.

Dr. Hoffman also has strong interests in supporting and retaining women of color and white women in the physical sciences; she is a co-director of DU SciTech, a summer STEM camp and academic mentoring program for middle-school girls of color in Denver.

Dr. Jennifer L. Hoffman, Associate Professor of Physics & Astronomy, University of Denver

The meeting will be held at **DU's Olin Hall, Room 105**, and all present will be invited to a reception following the meeting at DU's Historic Chamberlin Observatory. Coffee and light refreshments will be served.

August In-Reach: Dark Site Orientation & Learning Your Way Around the Sky

Saturday, August 12th, 7:00PM-11:00PM: We will be going "far afield" for the August 2017 DAS member In-Reach event. The DAS Dark Site is about 60 miles from the Mousetrap in Denver, about 8 miles to the East of the little town of Deer Trail. *See the Dark Site Web Page for general information on the site, and directions* (https://www.denverastro.org/das/egk-dark-site-2/).

The agenda will include:

1. Dark Site orientation, providing all you need to know about using the Dark Site facilities.
2. Brief summary of the history and culture of the site, including its wildlife.
3. Tour and demonstration of the Brooks Observatory, which houses a 14-inch Schmidt-Cassegrain telescope.
4. Opportunity to view the Milky Way and use your telescope or others provided to locate and view deep sky objects like galaxies, globular clusters, and planetary nebulae. **Experienced DAS volunteers will be on hand to get you used to finding objects in a truly dark sky.**
5. Spectacular views of the Perseid Meteors, which will be at their peak on August 12th.

**Don't forget warm clothes (it can get cold even in summer), hot beverages, and *a red flashlight.*

Eclipse Photos Wanted for the Observer

Generally, we recommend that you spend your time *observing* this month's solar eclipse, rather than photographing it, especially if you've never seen one before. Still, some folks will be shooting—if you have an image you'd like to share in our upcoming *Observer* "2017 Eclipse" feature, please do! We're looking for images not just of the eclipse, but of the *experience*, including the crowd's reaction before, during, or after the eclipse; and of DASers helping out. Please send your images and a brief caption to editor@denverastro.org.

September In-Reach: Member Roundtables

Saturday, September 2nd, 7:00-9:00 PM: There's a new approach on tap for the September In-Reach event! Most of our members have not had the opportunity to communicate with one another, especially face to face. Anchored in the belief that our club will be strengthened if our members get to know one another, *this In-Reach is designed to foster the creation of connections* that will enable each member to get more out of his or her membership.

The venue for this In-Reach is only a few blocks from Chamberlin. It is the **Rocky Mountain Miracle Center,** located at **1939 S. Monroe Street (on the NW corner of Buchtel and Monroe)**.

Using seven different Conversation Tables (which aren't actually round, sorry!), some with themes, we welcome long-time and newer members alike to sit down and talk about astronomy. Each table will have a moderator, and those with specific subjects (such as the Loaner Scope program, Astrophotography, Volunteering, etc.) will have at least one person who can answer questions.

Once or twice during the evening, we'll take a stretch break and encourage you to move to another table that interests you.

Our moderators will give us feedback on discussions, and help identify even more areas where we can assist you in learning more about the hobby and how to better enjoy it. It is our hope that you will make new friends and find ways to interact both at club events and on your own, and give us the information we need to serve you better. Please join us!

TWENTY YEARS AGO ON MARS

NASA Space Place

by Linda Hermans-Killiam

NASA has recently changed the focus of their "Space Place" articles to make them more kid-friendly, and we will run them from time to time, with the next generation in mind. —Editor.

The Mars Pathfinder lander took this photo of its small rover, called Sojourner. Here, Sojourner is investigating a rock on Mars.

Image credit: NASA/JPL-Caltech

On July 4, 1997, NASA's Mars Pathfinder landed on the surface of Mars. It landed in an ancient flood plain that is now dry and covered with rocks. Pathfinder's mission was to study the Martian climate, atmosphere and geology. At the same time, the mission was also testing lots of new technologies.

For example, the Pathfinder mission tried a brand-new way of landing on Mars. After speeding into the Martian atmosphere, Pathfinder used a parachute to slow down and drift toward the surface of the Red Planet. Before landing, Pathfinder inflated huge airbags around itself. The spacecraft released its parachute and dropped to the ground, bouncing on its airbags about 15 times. After Pathfinder came to a stop, the airbags deflated.

Before Pathfinder, spacecraft had to use lots of fuel to slow down for a safe landing on another planet. Pathfinder's airbags allowed engineers to use and store less fuel for the landing. This made the mission less expensive. After seeing the successful Pathfinder landing, future missions used this airbag technique, too!

Pathfinder had two parts: a lander that stayed in one place, and a wheeled rover that could move around. The Pathfinder lander had special instruments to study Martian weather. These instruments measured air temperature, pressure and winds. The measurements helped us better understand the climate of Mars.

The lander also had a camera for taking images of the Martian landscape. The lander sent back more than 16,000 pictures of Mars. Its last signal was sent to Earth on Sept. 27, 1997. The Pathfinder lander was renamed the Carl Sagan Memorial Station. Carl Sagan was a well-known astronomer and science educator.

Pathfinder also carried the very first rover to Mars. This remotely-controlled rover was about the size of a microwave oven and was called Sojourner. It was named to honor Sojourner Truth, who fought for African-American and women's rights. Two days after Pathfinder landed, Sojourner rolled onto the surface of Mars. Sojourner gathered data on Martian rocks and soil. The rover also carried cameras. In the three months that Sojourner operated on Mars, the rover took more than 550 photos!

Pathfinder helped us learn how to better design missions to Mars. It gave us valuable new information on the Martian climate and surface. Together, these things helped lay the groundwork for future missions to Mars.

Learn more about the Sojourner rover at the NASA Space Place: https://spaceplace.nasa.gov/mars-sojourner.

This article is provided by NASA Space Place. With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology. Visit spaceplace.nasa.gov to explore space and Earth science!

President's Message

Continued from Page 2

enough that its light can *instantly* cause permanent eye damage, including during annular and partial eclipses (and even when the Sun is as much as 99 percent obscured!). I want to reemphasize some of the safety tips that were pointed out in the June *Observer* and at the July DAS meeting:

1. You MUST use a proper and safe filter on your telescope and binoculars. Most solar filters are mounted on the front or objective end of the telescope (or binoculars). The only exception is a Herschel wedge, which is a special filter that is installed at the eyepiece end of a refractor telescope (and only a refractor!).
2. *Do not* use those screw-on-the-eyepiece solar filters that used to be included with low-cost telescopes. The filters can overheat and crack, resulting in focused and highly concentrated solar energy reaching and damaging the eye.
3. If you're planning to photograph the eclipse, don't forget that your camera will need a solar filter for the front of its lens during the partial phases (and when no eclipse is happening). If the camera has a separate lens for the viewfinder, that will need a filter, too.
4. For unaided-eye viewing of the Sun during the partial phases of a solar eclipse, use a safe filter such as certified eclipse glasses that meet ISO 12312-2. Eclipse glasses are worn just like regular sunglasses. Inspect the glasses before use; if the filters have pinholes, rips, or are damaged in any way, do not attempt to look at the Sun with them. *Under no circumstances should you use eclipse glasses to look through binoculars or a telescope.*
5. An alternative to eclipse glasses is #14 welder's glass, which can be ordered from a welding supply shop. Do not use anything rated less than #14, because it may not safely block all wavelengths of light.
6. *Do not* use old CDs or DVDs, neutral density (ND) filters (even stacked ND filters), sunglasses, regular Mylar film, or other "tricks." There is simply too much risk of eye damage.
7. Only during the brief period of totality can one safely observe the Sun without solar filters. Totality for this month's eclipse varies from about 2 minutes to a bit more than 2½ minutes, depending on location.

If you don't have access to solar filters (it's almost certainly too late to try to order them now), you can use pinhole or optical projection to safely look at an image of the Sun. Instructions are available at https://eclipse.aas.org/eye-safety/projection.

One last thing: **For those of you who are planning to drive to Wyoming the morning of the eclipse,** plan on leaving the Denver area no later than about 3:00 or 4:00 AM. Depart any later than that, and you'll likely discover that northbound Interstate 25 is a parking lot most or all of the way to Casper. Don't risk missing totality because of a traffic jam.

Now let's cross our fingers for clear skies on the 21st, and a safe and absolutely amazing eclipse experience!

August Skies

Continued from Page 1

Stars and Deep Sky

The August sky offers a huge list of wonders, stretching from the center of our Milky Way galaxy in Sagittarius northward through the Summer Triangle. We've explored some of this in the "Monthly Skies" in the past two August *Observers* (see the August 2016 issue at http://www.denverastro.org/newsletters/august2016_denverobserver.pdf, and for 2015 at http://www.denverastro.org/newsletters/august2015_denverobserver.pdf). This time around, let's take a look at an area of the sky that's less-traveled—the Little Dipper and Draco.

Our first stop is **Polaris**, also known as **Alpha (α) Ursae Minoris** or **α UMi**—and colloquially as the **North Star**. That nickname comes from its location **(+89° 20', 2h 54m**), about ⅔ of a degree from the north celestial pole, making Polaris a guide for generations of navigators and astronomers alike. Because this star lies so close to the axis around which the Earth spins, it barely changes position, making it a useful tool for amateur astronomers aligning finderscopes, or collimating the main instrument. (It's also commonly used for setting up go-to systems.)

In talking with amateur astronomers, though, I've been surprised at how few realize that Polaris is also an interesting star in its own right—for starters, it's a binary. The bright, 2nd-magnitude primary is joined by a 9th-magnitude companion about 19" away; the pair splits in my 6-inch at high power, even in Denver's choppy skies. (19 arc-seconds is actually pretty wide, but the brightness difference between the primary and the companion make it more

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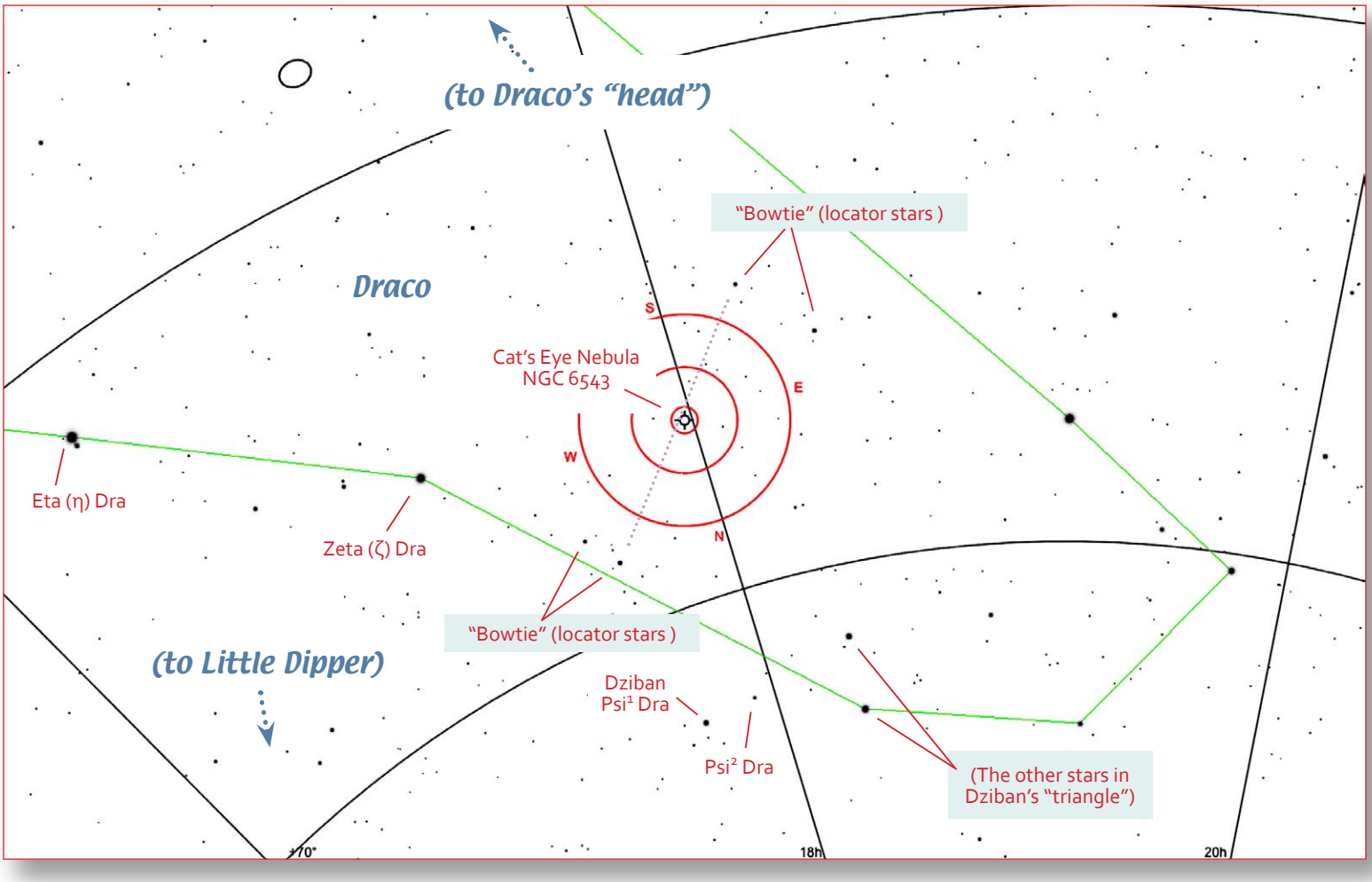
ABOUT THE DENVER ASTRONOMICAL SOCIETY

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.**



Detail view of Draco, looking *due north* in Denver skies at 10:00 PM in mid-August; center of chart is 62° above the horizon at that time. As with the main chart on page 1, the orientation here is "upside-down" from traditional charts, but correct for naked-eye observers looking in this direction. **For improved precision positioning the Telrad on the Cat's Eye, center the Telrad along the dotted line between the two "bowtie" stars, as indicated.

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

August Skies

Continued from Page 5

challenging.) In my 12-inch Newtonian, 60x will do the trick on a calm night, but higher powers are still preferable. In either 'scope, the pair appears a striking bright white and medium gray.

The primary, α UMi A, is a rather bright class F7 supergiant, with a surface temperature just below 6000 K—just a tad hotter than our Sun. This star is also a Cepheid variable—it finished fusing hydrogen, and has since expanded dramatically in size, fluctuating consistently in brightness. (Cepheids are important to astronomers as "standard candles," because the *period* of their brightness variations is directly related to their actual brightness—measuring stars like these in other galaxies tells us how far away the host galaxy is.) Though not famous for it, Polaris is actually the brightest Cepheid in our sky.

The secondary, the "dim" gray companion, is itself a class-F3 star with about 28 times our Sun's intrinsic brightness, illustrating the power of the primary! (The secondary is on the main sequence of stars, burning hydrogen in its core, and is therefore of a more usual brightness for stars of its class.) The Polaris system lies about 430 light-years from Earth, so the 19" between the pair suggests a physical separation of about 2,400 astronomical units (AU); Prof. James Kaler (University of Illinois) lists the orbital period at more than 42,000 years.

There is a *third* star, another of class-F, similar to the secondary, orbiting tightly around the primary. It was detected by spectroscopy; Robert Burnham, Jr. notes preliminary reports on this then-unseen companion from 1929 and 1955, but even at the time of Burnham's *Celestial Handbook*, little was known beyond a rough orbital period. Today, we know it's an F7, with about 1.25 solar masses; astronomers are now certain that it orbits in about 30 years at an average distance of 19 AU. The Hubble Telescope imaged this star directly in 2006; see http://hubblesite.org/image/1842/news_release/2006-02 for image links and information.

Finally, there's the "good news and the bad news" about Polaris: On the upside, Polaris is *circumpolar*—literally, the word means "circling or *around* the pole," but astronomers mean that at a given latitude, such an object never sets—it's visible all night, throughout the year. For us in the Northern Hemisphere, there's no bright star that fits either definition more perfectly than Polaris—it's "very" circumpolar!

On the downside, beginners using an equatorial mount will find this star difficult to point their telescope to. The problem is in the geometry of the mount itself—all but the most exotic telescope mounts (not just equatorials) rotate around a primary axis, and have trouble pointing to targets close to that axis. Dobsonian telescopes, for example, have difficulty aiming well

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August Skies

Continued from Page 6

when looking straight up; equatorial users have trouble pointing towards their polar axis, and Polaris sits right there.

To find Polaris from Denver, face due north and look 40° up! Around 10 PM this time of year, you'll see the Big Dipper just off to your left towards the northwest; the two stars in the bowl farthest from the dipper's handle point to Polaris, helping confirm the North Star's identity.

As some of you might surmise from its "Alpha" name, Alpha Ursae Minoris, Polaris is the brightest star of Ursa Minor—which, in turn, is more popularly known as the Little Dipper. This constellation is usually washed out in the city, but easy in suburban skies (like near Chatfield Reservoir), and, of course, out in the country. It's a great jumping-off point for the constellation Draco, where our other two targets reside.

Draco, the Dragon, is a large, if somewhat dim constellation, and like the Little Dipper, its outline is difficult to see under city lights. From the edges of Denver's light-dome though, it's easily made out if you know where to look. Its "head," a polygon with bright stars for "eyes," sits just north of Hercules; the "body" of the sprawling constellation then winds towards Cepheus and Cassiopeia before turning 180° to swing its curving tail around the Little Dipper. This last section, just after the 180° turn, is where we'll find our second and third targets.

Our next pursuit, then, is the double star **Dziban**, also known as **Psi^1 (ψ^1) Draconis,** or simply **Psi Dra**, at **17h 42m, +72° 09'**. Sources disagree on the pair's exact brightnesses as seen from Earth, but the stars are reasonably described as of the 5th and 6th magnitudes.

In my notes from three years ago, I wrote that Dziban is "A nice double; two matched, subtly cream-colored stars, widely separated." Ironically, I didn't recognize it at first, because I was expecting a "cream and lilac" pair, as Dziban is often described. Notes from this past June record a "bright-white and white pair"—still no "lilac"! As always, star colors are subjective and depend on current conditions and the equipment you're looking through, but Dziban is a pretty pair, regardless. It splits easily at 60x, and is lovely at 120x.

Dziban is an interesting star-system, as well. Again according to Prof. Kaler, the brighter of the pair is about half-again more massive than our Sun, and has a close-in, red-dwarf companion detected spectroscopically—so now we're talking about a triple-star system, even though we can't see the third one. The red dwarf orbits at an average distance a little less than Saturn's distance to the Sun.

The companion we do see in our 'scopes is just a bit more massive (and hotter) than our Sun, and less than a magnitude brighter. Orbiting at least 700 AU from the primary, this star has two Jupiter-like planets orbiting around it. The professor has more to say about Dziban than I can include here, and his information is quite recent, quoting a paper from 2016—you can find his full description at http://stars.astro.illinois.edu/sow/psidra.html.

In a dark enough sky, Dziban is easily found in a little triangle of stars lying about the same distance from Polaris as does Pherkad, the star at the far corner of the Little Dipper. Imagine Pherkad on a circle with Polaris at the center, and move your eyes clockwise about 40° until you pick up the triangle with Dziban in it—see chart. Alternatively, you can look down the dipper's handle from Polaris until you come to the close part of the bowl, and make a clockwise, perpendicular turn—the distance from the turn to Dziban is about ⅔ of the handle's length. (A third method is to follow Draco's curving body—see the directions for NGC 6543, below.)

Note that Dziban is part of a binocular double—the other star is "Psi^2." This unrelated star sits inside the triangle you're looking for, and at magnitude 5.4, it may go unnoticed naked-eye, fooling you when you're looking for Dziban in your finderscope. To avoid this, remember that Psi^2 is noticeably dimmer in the finderscope than the "real" stars of the naked-eye triangle, and that Dziban is *farther* from the other two triangle stars than Psi^2.

**For the DASers who use Orion Intelliscope dobs, note that Dziban is shown as "Σ 2241" in the controller's database. (The "Σ" means this listing originally came from the Struve double-star catalog.)

Our last object for August is the **Cat's Eye Nebula, NGC 6543,** at **17h 59m, +66° 38'**. This blue planetary is bright enough to be seen by small telescopes, and, at least in larger telescopes, is easily visible in the city, too.

Like many planetary nebulae, this one appears starlike at low power—but 6543 strikes me as more "stubborn" than others, maintaining its stellar appearance at 40x, and only beginning to reveal its true nature at 60x or better, in a large telescope. At that point, direct vision picks up the nebula's blue color and it might remind you of Uranus, another tiny blue object; under averted vision, though, the nebula finally looks a bit "fuzzy." (As with some similar nebulae, alternating between direct and inverted vision causes 6543 to "blink.")

By 120x or so, it's obvious this isn't a star, and the nebula's shape becomes more distinct. In larger 'scopes, crank the power to 200x, and 300x if conditions permit—the nebula's oval shape will become more apparent, and depending on seeing conditions and aperture, you could see detail and mottling within.

Images in visible light and other wavelengths have revealed an inner structure filled with complex "shells" of glowing gas and dust, which astronomers believe are the result of cyclical ejections of the central star's (or stars') atmosphere. Most photos, like the very detailed Hubble image at https://www.nasa.gov/multimedia/imagegallery/image_feature_211.html, show roughly the same, well-known area as you see visually in your telescope, but deep exposures with a wider field reveal a much larger halo surrounding the inner oval. When you observe NGC 6543, a noticeable 10th-magnitude star lies just 2.5' to the northeast, sharing even a high-power field. That star is the same one visible at upper right in the wide view of the nebula on page 8. (If the nebula is indeed at its estimated 3,300 light year distance from us, the roughly 5 arc-minute diameter of that large outer halo works out to a physical size of about 4.8 light-years.)

Finding the Cat's Eye by star-hopping is both easy and difficult—easy because you can get very close with relatively little effort, but difficult because you can be looking straight at it at low power (or in a finderscope) without recognizing your prize. (There have been times when I found the nebula quickly, and shared the view with observers, only to have trouble finding it again soon afterward.) Since finderscopes will be of so little help, I recommend putting extra care

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into initial positioning with a Telrad, and then going straight to 60-100x in the main instrument to look for the nebula there.

Our goal, then, is to center the Telrad between four 5th-magnitude stars which are arranged like the corners of an uneven bowtie with the nebula in the middle. They're obvious under dark skies once you're looking in the right spot, and you get to that spot by following the Dragon's curving body.

An easy starting point for this is Eta (η) Draconis, one of the brightest stars in Draco, at magnitude 2.7. If you first go to *Kochab*, the bright star at the end of the scoop in the Little Dipper, and then make a line from there to *Pherkad* (the star we'd looked at before that's farthest from Polaris), that line continues straight to Eta—it's the next bright star. (See charts on pages 1 and 6.)

From Eta, turn "right" relative to the line you just followed, to pick up Zeta (ζ) Dra, slightly dimmer at magnitude 3.2. Matching your view of the stars to the chart at this point reveals you're now following the curving body of Draco—Zeta is at a slight bend, and if you continue along Draco for about the same distance as from Eta to Zeta, you'll find our little triangle that includes Dziban! (This is the "third way" to get to Dziban that I'd mentioned in directions for that star, and this approach has worked well for me in less-perfect skies when the triangle wasn't as visible as it could've been.)

Now that you've got Zeta and Dziban, look halfway between them for two of the "bowtie" stars—they're about ½° apart, just inside the Zeta-Dziban line. Imagine another line running perpendicular to this pair, and follow it a little less than 6°, *away from the Little Dipper*, and you'll see the other half of the bowtie. For the best positioning, center your Telrad between the diagonally opposed bowtie-stars, as shown linked by a dotted line in the close-up chart on page 6.

Wide view of NGC 6543. *Credit: Nordic Optical Telescope and Romano Corradi (Isaac Newton Group of Telescopes, Spain)*

For future reference, Draco's stars will dim a bit before they sweep around and "upwards" towards the dragon's head. If you follow this trail a few times, it will become familiar to you and will help you keep your orientation in this part of the sky, as it rotates around the pole through the evenings and across the seasons—remember, this part of our sky never sets! (Though we don't have space to delve into it here, the area around Draco's head is filled with many more interesting binaries, and there are noteworthy galaxies elsewhere along the dragon's body…. Happy exploring!)

—See you next month.

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