The Denver
OBSERVER
DECEMBER 2016

The Pacman Nebula, NGC 281, in Cassiopeia. Though not covered this month, it is a fine target for amateur telescopes—like many others in the constellation.
Image © Darrell Dodge

DECEMBER SKIES

by Zachary Singer

The Solar System

This month, some familiar objects are going or gone, while others are becoming good targets again. Before starting on the planets, though, there's the **occultation of Aldebaran on the 12th.** Because of the way the Moon's orbit is now aligned, there have been quite a number of these events, each with its own particular qualities—the last one, in parts of Denver, was a "grazing occultation," for example. Some occurred at a convenient local time, and others in the wee hours.

This one happens at ***approximately* 8:22 PM, Mountain Standard Time, for observers in southern Denver,** with an almost-full Moon. The advancing edge of the Moon, though, will be dark—which is both good news and bad. On the good side, telescopic views won't be as washed out as they would be by a brightly lit lunar edge, so it will be easier to see Aldebaran "wink out" as the Moon passes in front of it. On the bad side, though, that dark, invisible edge means you won't have as good a sense of the Moon's approach to the star, and you'll need to watch more closely to make sure you don't miss it in the last few seconds.

As with all events like this, it's a good idea to be set up and looking many minutes in advance. In part, that's so that you can witness an important part of the spectacle—watching the Moon move in its orbit as it advances toward the star. But it's also important because timings depend on your location—the prediction is 8:22:02 PM (up or down a few seconds) for my address north of the Denver Tech Center, but 8:20:56 in Colorado Springs—a full minute earlier. (By the same token, residents of Casper won't see it until 8:26.)

Sky Calendar

7	First-Quarter Moon
12	Occultation of Aldebaran
13	Full Moon
20	Last-Quarter Moon
28	New Moon

Turning now to the planets, we have **Mercury,** which will be visible, *very* low on the western horizon at dusk, in the beginning of December. Unless you observe during daylight, telescopic views will be blurry at best, because of the planet's lack of altitude, and the planet will disappear into the solar glare just after midmonth. (*If you choose the daylight option, be very careful not to point the 'scope at the Sun.*)

Venus, though, is another story! Though it's still not great at the beginning of the month, just 15½° up at 5:45 PM and 17" across, it rises to a more workable 20° and 19" in apparent diameter by midmonth,

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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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The Executive Board conducts the business of the DAS at 7:30 PM, at Chamberlin Observatory. Please see the Schedule of Events for meeting dates. All members are welcome.

http://www.denverastro.org

PRESIDENT'S MESSAGE

by Ron Hranac

Stonehenge

I've been traveling to the United Kingdom on business since the late 1980s, and over the years managed to squeeze in visits to various museums and popular tourist destinations when time allowed. For whatever reason, I never made it to Stonehenge, one of England's most well-known landmarks. That is, until a couple months ago. During a mid-October trip to London I had an extra day in the schedule, so I contacted the hotel concierge and booked a half-day tour of Stonehenge.

I've heard from some that Stonehenge is underwhelming ("It's not as big as I thought it would be…"), but I found the opposite to be true. The tour itself was self-guided, using a headset and portable audio player, and pretty straightforward: Reach one of several small numbered signs along the path around the monument, and press the corresponding number on the audio player. The recorded lectures were quite informative.

Why Stonehenge? Well, it's an interesting archaeological site, that still presents many unsettled questions. But Stonehenge also has an astronomical component, too. Indeed, one could argue that Stonehenge falls under something known as archeoastronomy. According to Wikipedia (*https://en.wikipedia.org/wiki/Archaeoastronomy*), "Archaeoastronomy is the study of how people in the past 'have understood the phenomena in the sky, how they used these phenomena, and what role the sky played in their cultures.'"

Stonehenge has a northeast-to-southwest alignment that results in the Sun rising behind what is called the Heel Stone on the summer solstice. A similar event used to occur on the winter solstice, when sunset occurs exactly opposite the summer solstice sunrise—while it was still intact, the stones of the Great Trilithon were arranged to frame the setting winter Sun. Interestingly, these alignments aren't unique to Stonehenge. Other henges constructed around the same time have comparable arrangements.

For instance, the nearby Woodhenge (yes, there really is a Woodhenge) also aligned with the solstices. Woodhenge was originally built with wooden posts, which have long since rotted away. Today, concrete posts stand where the original wooden ones once did.

I learned a lot during the visit to Stonehenge—it turns out the site was created in stages. Around 3000 B.C., the first Stonehenge was built, which was largely just a circular ditch and embankment, or "henge." The stones were erected on the same site some five hundred years later, circa 2500 B.C.

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DAS SCHEDULE

DECEMBER 2016

3	Open House—DU's Historic Chamberlin Observatory—Starts at 5:30 PM
11	DAS Holiday Party (see Page 5)
16	E-Board Meeting—At DU's Historic Chamberlin Observatory, 7:30 PM
31	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.

DAS NEWS

Volunteer Opportunities

Thursday, December 15th, 6:00PM. Montessori School of Denver, 1460 S. Holly St., Denver, CO 80222. Night observing for 4th & 5th graders studying astronomy.

January 2017, from 1:20-2:00PM, date TBD (would like a couple of days). Vanguard Classical School, 17101 E. Ohio Dr., Aurora, CO. Question and answer session via Skype with an amateur astronomer. First-graders studying astronomy (fulfills a requirement for online communication)

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

Stonehenge, 2016 ***Image © Ron Hranac***

President's Message

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Work continued on the stones for hundreds of years.

There have been all kinds of theories about who built Stonehenge. Scientists agree that the Druids did not build it, nor did the Romans (Stonehenge pre-dates both groups). Some authorities in Medieval times wrote that Merlin—yes, *that* Merlin—erected the stones using magic. Exactly who built Stonehenge is uncertain, as is how it was built and why.

Another mystery involves how many of the monument's stones got from their places of origin to the Salisbury Plain, where Stonehenge is located. For example, the largest stones (some of which weigh upwards of 35 tons each), called sarsens, are a type of sandstone that originated in an area known as Marlborough Downs, about 19 miles north of Stonehenge. Smaller stones, called bluestones, came from Preseli Hills in Wales—150 miles to the west!

When most people think of Stonehenge, they think of the well-known stone monument. But there's much more. The surrounding landscape is covered with burial mounds called barrows. There are also unusual monuments such as the Stonehenge Cursus, an earthwork enclosure about 1.7 miles long and 330 feet wide. The Cursus's function remains unknown, although some scholars once thought that perhaps the Romans built it for chariot racing or the like. (The Stonehenge Cursus was actually constructed far earlier, in 3400 B.C.) Explorations of the area around Stonehenge in 2013 using ground-penetrating radar and similar technology uncovered a lot more.

Stonehenge is a fascinating place. Should your travels take you to the U.K., try to make it to the site. I think you'll be glad you did.

DIMMING STARS, ERUPTING PLASMA, AND BEAUTIFUL NEBULAE

By Marcus Woo

NASA Space Place

Boasting intricate patterns and translucent colors, planetary nebulae are among the most beautiful sights in the universe. How they got their shapes is complicated, but astronomers think they've solved part of the mystery—with giant blobs of plasma shooting through space at half a million miles per hour.

Planetary nebulae are shells of gas and dust blown off from a dying, giant star. Most nebulae aren't spherical, but can have multiple lobes extending from opposite sides—possibly generated by powerful jets erupting from the star.

Using the Hubble Space Telescope, astronomers discovered blobs of plasma that could form some of these lobes. "We're quite excited about this," says Raghvendra Sahai, an astronomer at NASA's Jet Propulsion Laboratory. "Nobody has really been able to come up with a good argument for why we have multipolar nebulae."

Sahai and his team discovered blobs launching from a red giant star 1,200 light years away, called V Hydrae. The plasma is 17,000 degrees Fahrenheit and spans 40 astronomical units—roughly the distance between the sun and Pluto. The blobs don't erupt continuously, but once every 8.5 years.

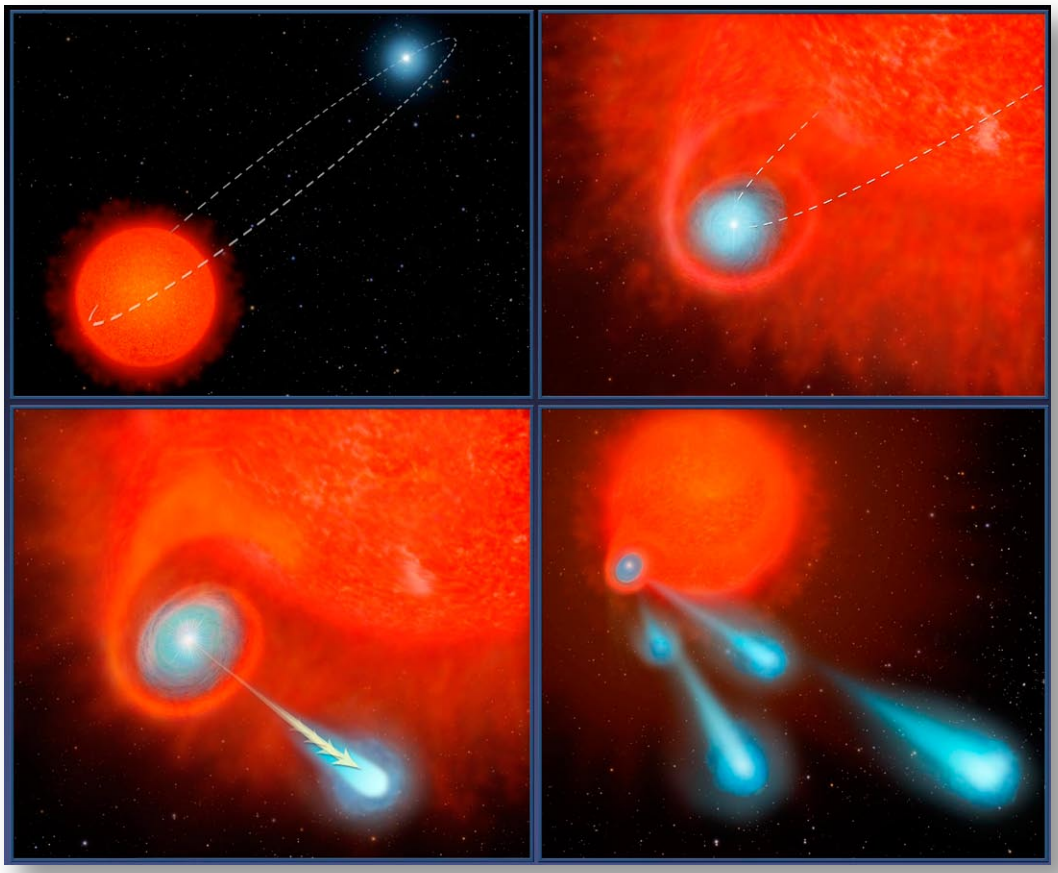
The launching pad of these blobs, the researchers propose, is a smaller, unseen star orbiting V Hydrae. The highly elliptical orbit brings the companion star through the outer layers of the red giant at closest approach. The companion's gravity pulls plasma from the red giant. The material settles into a disk as it spirals into the companion star, whose magnetic field channels the plasma out from its poles, hurling it into space. This happens once per orbit—every 8.5 years—at closest approach.

When the red giant exhausts its fuel, it will shrink and get very hot, producing ultraviolet radiation that will excite the shell of gas blown off from it in the past. This shell, with cavities carved in it by the cannon-balls that continue to be launched every 8.5 years, will thus become visible as a beautiful bipolar or multipolar planetary nebula.

The astronomers also discovered that the companion's disk appears to wobble, flinging the cannonballs in one direction during one orbit, and a slightly different one in the next. As a result, every other orbit, the flying blobs block starlight from the red giant, which explains why V Hydrae dims every 17 years. For decades, amateur astronomers have been monitoring this variability, making V Hydrae one of the most well-studied stars.

Because the star fires plasma in the same few directions repeatedly, the blobs would create multiple lobes in the nebula—and a pretty sight for future astronomers.

If you'd like to teach kids about how our sun compares to other stars, please visit the NASA Space Place: *http://spaceplace.nasa.gov/sun-compare/en/*



This four-panel graphic illustrates how the binary-star system V Hydrae is launching balls of plasma into space. Image credit: NASA/ESA/STScI

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!

DAS HOLIDAY PARTY

Join Us December 11th!

Come join other DAS members and guests for the 2016 Holiday Party! It will be held at the Embassy Suites by Hilton at the Denver Tech Center, on Sunday, December 11th, from 6 PM until 9:30 PM.

The Program

The night's Guest Speaker, John Bally, did his undergraduate studies at the University of California at Berkeley, and obtained his PhD in millimeter-wave radio astronomy at the University of Massachusetts at Amherst in 1980. Since 1991, he has been a professor of astrophysics in the Department of Astrophysical and Planetary Sciences at the University of Colorado, Boulder. He has made extensive use of the world's major observatories such as the Hubble, the facilities of the National Optical Astronomy Observatories, and the facilities on Mauna Kea in Hawaii such as Gemini and Caltech Sub-millimeter Observatory. He is now a user of the new Atacama Large Millimeter Array, ALMA, which is the most ambitious ground-based telescope ever built.

Dr. Bally has a way of making even the most esoteric-sounding concepts understandable. His current research includes the formation of stars and planetary systems, the first blind search for dense, dusty clumps that may soon or are currently forming clusters of stars. During the last decade, he has concentrated on massive star and cluster formation. He has recently rekindled his interests in cosmology and is exploring the Lee Smolin hypothesis of "cosmic natural selection" in which black holes produce Universes. This theory may provide an "explanation" for the so-called anthropic principle and for the small but non-zero value of the cosmological constant. This highly speculative and "risky" research direction is a natural outgrowth of his interest in massive stars, the most massive of which form stellar-mass black holes at the ends of their lives.

John Bally is an avid skier, and owns a home in Breckenridge, where he operates a small observatory.

Menu & Festivities

Doors open at 6:00 PM. Dinner served at 7:00 PM. In addition to a wonderful sit-down meal, there will be a cash bar and plenty of room for meeting and greeting.

Salad
Mixed greens, sun-dried tomatoes, bacon, Parmesan cheese, lemon vinaigrette

Entrees
Maple-brined chicken / cherry wild rice / green beans / fig cream

Butternut squash ravioli / hazelnut brown butter / haystack mountain goat cheese

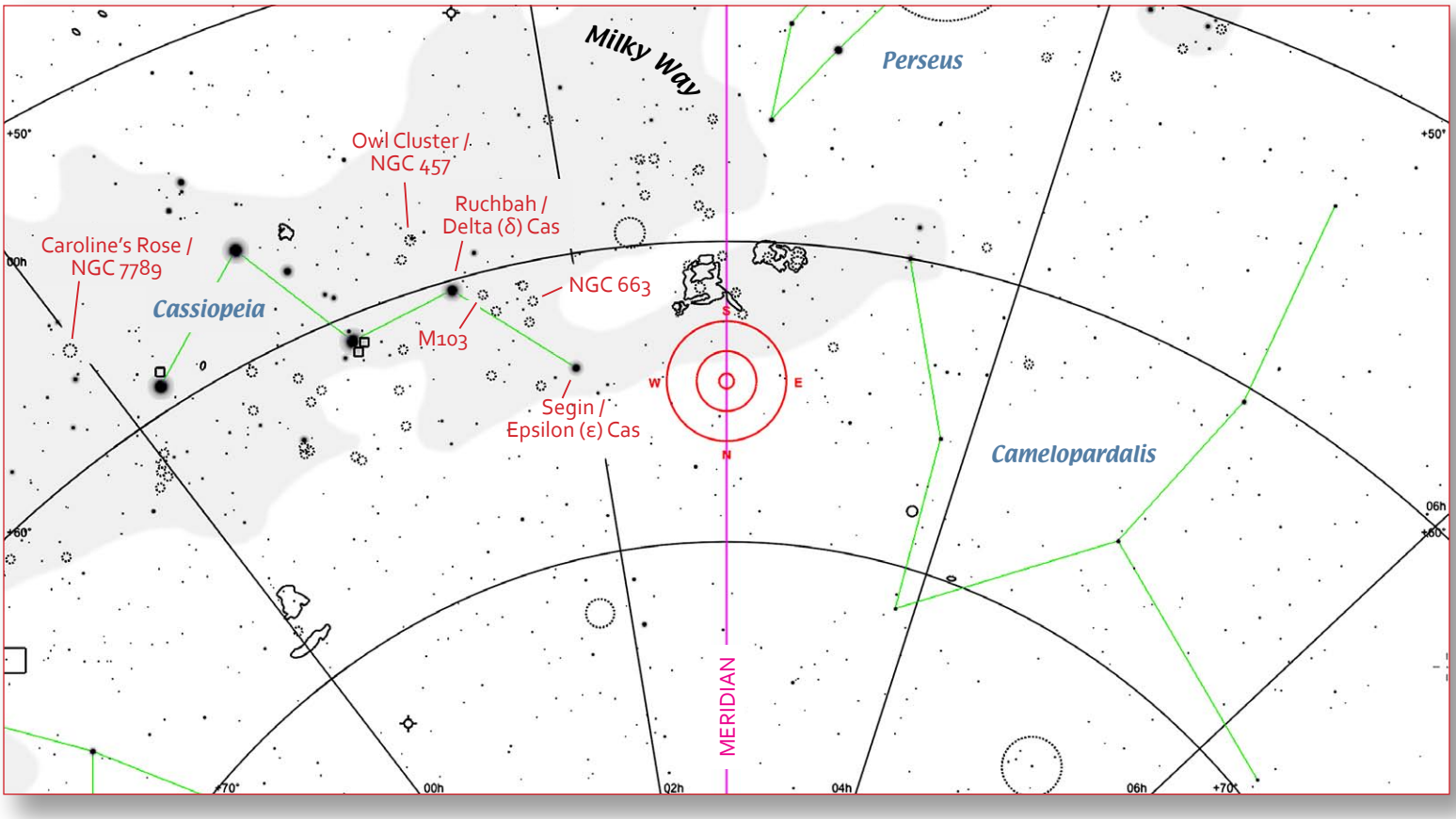
Dessert
Cheesecake / seasonal fruit sauce

Reservations

Beginning November 19th—Reservations Limited—DAS Members and Guests Only
Cost: $25 per person.

For more information, and to make reservations online, please see:
http://www.denverastro.org/das/event/holiday-party-december-2016/

***** Reservations must be received by midnight, December 6th! (No Walk-up Seating at the Event)**



Viewing *north* and up in Denver at 9:00 PM in mid-December. Telrad center is 65° above the local horizon. Note the Owl Cluster (NGC 457) and Caroline's Rose (NGC 7789) from last month, and this month's M103 and NGC 663 for reference—*the latter two are shown in greater detail on page 7.*

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

December Skies

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and 27° and 22" at New Year's. With a magnitude of -4.3 at month's end, it won't be hard to spot; and the phase, declining from gibbous to 50% illuminated, will be interesting too.

Mars is slowly retiring, and shrinks to about 6" by month's end. Still, it has a trick up its sleeve—if your New Year's plans start in the later evening, you can observe as **Mars passes close by Neptune at dusk on New Year's Eve.** At 5:45 PM, about an hour after sunset, the two planets will be just 11' apart—close enough to fit at 200x easily, if your eyepiece has a 60° apparent field. At that time, the pair will be about 36° above the southwestern horizon; as the hours pass, they will come even closer to each other, but also lower in altitude. Start early, and see how far you get. (Even without the spectacle of the conjunction, it's also an opportunity to find 8th-magnitude Neptune very easily, simply by finding 1st-magnitude Mars first—Neptune will be the next-brightest object in a ½° field when you center Mars.)

Jupiter is in increasingly good form—at the beginning of the month, it's more than 30° up in the southeast at 5:45 AM, when sunrise is still an hour and 15 minutes away. By New Year's, Jupiter will be even higher, in the south, at the same hour—the planet will actually transit a half-hour before dawn.

Saturn is gone for now, lost this month in the Sun's brightness. Look for it again early next year as a morning object.

Uranus is just east of where we left it last month, and conveniently a little closer to Zeta (ζ) Piscium. This new proximity means that centering Zeta brings Uranus near the middle of your finderscope, where the two make a noticeable triangle with 88 Piscium—Uranus is the blue one! In theory, this triangle should be a dim naked-eye object under clear, dark skies—but as noted last month, if 5th-magnitude Zeta is hard to find, make a quick starhop from 4th-mag. Epsilon (ϵ), which is about 2½° to the west.

Stars and Deep Sky

Adding to last month's tour, we're going to take another look at open clusters in Cassiopeia, a little further to the east this time, and compare them. (If you missed last month's *Observer,* it's available online at: *http://www.denverastro.org/newsletters/november2016_denverobserver.pdf*) As it happens, one of this month's clusters often appears in observing lists for beginners; the other, though not hard to find, is an interesting object, but often missed—even by experienced observers.

The first cluster, **M103,** at **1h 35m, +60° 44',** is just on the other side of Ruchbah, or Delta (δ) Cassiopeiae, the star we used to find the Owl Cluster, NGC 457, last month. Interestingly, the two clusters aren't just close to each other by line of sight, they're also about equally far away (8,000-10,000 light-years), and therefore, relative neighbors in space. Since they're roughly the same distance from us, the differences in their sizes and brightness can be compared directly—when you do, make sure to use the same telescope and eyepiece. (The same goes for our second cluster this month, NGC 663, but we'll get to that later.)

When you look at M103 after viewing the Owl, you'll notice that it's much smaller, at 5 minutes of arc across

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December Skies

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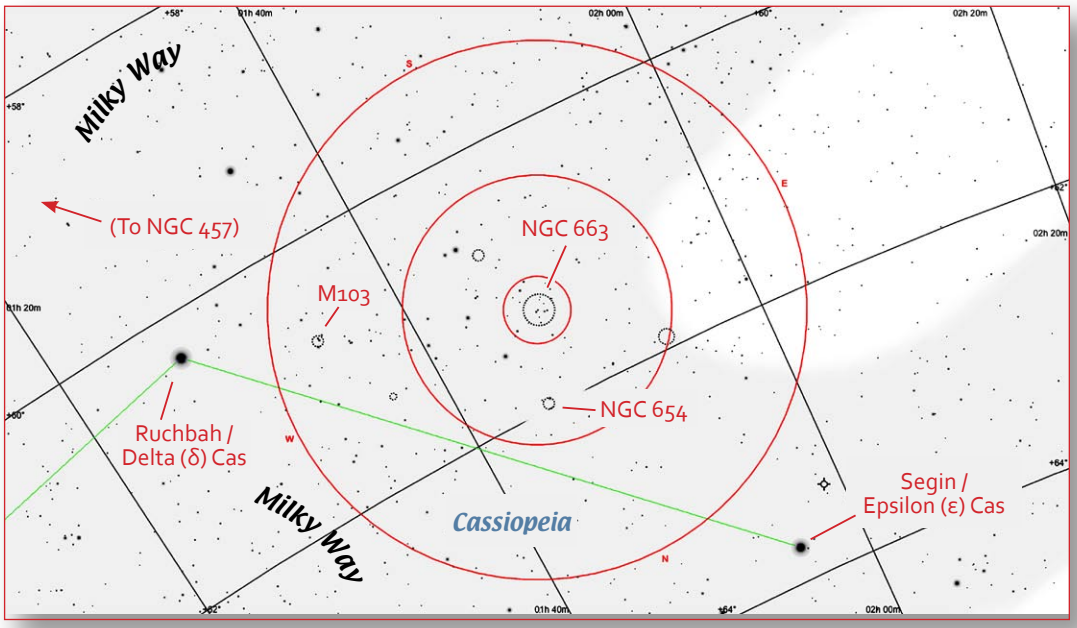
instead of the Owl's 20 minutes, but with a higher surface brightness. Brightness differences may be due in part to intervening dust, but the difference in size is really there—estimates for M103's diameter range from 10 to 15 light-years, while the Owl is about 45 light-years across—clearly, all open clusters aren't built the same way!

If you go looking through astronomical observers' notes, you'll discover that visual impressions of M103 are mixed—some writers have loved it (for a lovely mix of colors, and Struve 131, a double star), and some find it lacking (the cluster fades into the rich Milky Way background). In our case, the comparison between clusters is interesting, and I will leave the subjective aspects to you—M103 is easy enough to find to be worthwhile, even if it doesn't make your favorites list.

To find M103, first *look northward,* and note that Cassiopeia's classic "W" shape appears more like an "M" in this orientation. At 9 PM midmonth, the "M" lies just to the west of (to the left), and above the North Star, Polaris. Find Ruchbah, the top-right star in the "M," and center it in your finderscope. M103 is just a degree away, just north of eastward—if you look carefully under dark skies, you should see a few of its brighter, 7th- and 8th-magnitude stars glowing tightly together, even in a 6x30 finder. Don't be confused by the other clusters in this area—M103 is the closest one to Ruchbah.

If you can't see M103 in the finderscope, *use your Telrad instead.* Center it on Ruchbah, then imagine the line running from there to Segin, or Epsilon (ϵ) Cassiopeia. Slide the center of the Telrad down the line toward Segin until the Telrad's 2° circle touches Ruchbah (i.e., move the Telrad 1° towards Segin). Now nudge the Telrad at a right angle from the direction you were just going, away from Cassiopeia's center. About a half of a degree, or the width of the Telrad's centermost circle, is all the "nudge" you'll need to put M103 in your telescope's eyepiece.



Close-up of the area around M103, NGC 663 and NGC 654. Note position of Telrad circle, with "middle" 2° circle just "a kiss" off the line from Ruchbah and Segin, when NGC 663 is centered.

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

Our second open cluster, **NGC 663,** at **1h 47m, +61° 19'**, as briefly mentioned, is also roughly the same distance from us as the Owl and M103, so we can compare this one to the others, too. You'll find a larger cluster than M103, but a smaller one than the Owl—663's diameter is estimated at around 32 light-years. Its surface brightness is the same as the Owl's, so it's as easy to see—just a touch smaller in your 'scope, when you use the same setup. (Small telescopes will pick it up nicely under dark skies.)

When you observe the two "new" clusters and last month's Owl, you'll notice they're all birds of a feather—no pun intended (*cough*). That is, they're all "young" clusters, dominated by populations of stars that are hot, bright, blue, and short-lived—the oldest of the clusters (and the stars within) is perhaps 25 million years in age, and the others are younger still. And these stars certainly *are* intrinsically bright—if our own Sun were at their distance, it would manage only 17th magnitude, too dim to be seen in a 15-inch 'scope.

Comparing the three clusters to last month's NGC 7789, aka Caroline's Rose, you'll sense the latter is different. It's larger, but the individual stars within it seem dimmer on an individual basis, even though the cluster is thought to be a bit closer than the other three (so 7789's stars should have been *brighter,* if all else were equal).

The discrepancy is due to 7789's advanced age—it's believed to be at least a *billion* years old, which is pretty ancient for an open cluster. Unlike the other clusters, the original, very hot stars here are gone, leaving many more of the dimmer, longer-lasting ones to carry on… (You can see this process beginning in the newer clusters—look for the bright, red stars in each cluster. They're the ones that have exhausted enough hydrogen to start "evolving" into cooler, redder, giants on the way to eventually calling it quits.)

A few of the brighter, 8th-magnitude stars in NGC 663 should be visible in a finderscope under dark skies. If you're still centered on M103, 663's stars will glow directly opposite from Ruchbah, but a little over half-again Ruchbah's distance from the center of the field, and noticeably closer to the finder's edge. There are other, smaller clusters in the area, so be careful you're in the right place (remember that Ruchbah, M103, and NGC 663 lie on a straight line).

If you can't see the cluster in the finder, though, or you're getting lost, there's another way: Carefully center your *Telrad* between Ruchbah and Segin, and then move the telescope at a right angle (from the line between the two stars) a little over a degree to the southeast—towards Perseus and away from the center of Cassiopeia. You've gone far enough when the northwest edge of the Telrad's 2° circle passes the line between Ruchbah and Segin, but a little "kiss" more will center the cluster better in the eyepiece. (Keep your telescope's power low until you know you're in the right spot.)

If you're up for it, check out NGC 654, a small, but bright little cluster about 2/3° from 663; it's on our chart, too.

—See you next year. (Happy Holidays!)

ABOUT THE DAS

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 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*.

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