

OBSERVER



The Crab Nebula, M1, in Taurus. A huge supernova remnant, it's visible even in small telescopes, and featured in this month's "Skies."

Image © Jon Martin

JANUARY SKIES

by Zachary Singer

Before anything else, warmest wishes to my predecessor, Dennis Cochran, who's moved to warmer climes in Southern California... He wrote this column for eight years, a record I'm nowhere near matching. Clear skies to you! —Zach Singer (See the story in "DAS News," p. 3.)

The Solar System

Mercury starts the new year about 9° west of the Sun, its relatively dim, +2.7-magnitude crescent just barely above the horizon a half-hour before sunrise—though the planet is then comparatively close to Earth, we see mostly its shadowed side. As the planet sweeps away from us, toward maximum elongation on the 19th, its illuminated area widens to a curving crescent; on the 7th, the planet will be much brighter at magnitude +0.6, and almost 9° above the southeastern horizon 30 minutes before the Sun's appearance. By the 12th, the planet looks like a "half-moon," and brightens to 0.0-mag.; on the 19th, Mercury achieves +0.2 mag. with a gibbous appearance—it's then 24° west of the Sun and another degree higher before sunrise. After that, the planet begins its arc around the

"back side" of its orbit (from our point of view), narrowing its angle from the Sun as it heads towards a superior conjunction on March 6th.

Venus is now a spectacular and unmistakable evening object in the western sky, glowing bright at magnitudes from -4.3 to -4.6 as January progresses. Unlike Mercury, Venus is catching up to us in its orbit, and will appear increasingly large this month—its roughly half-illuminated disk grows from 22" to 31". (Next month, it will appear more crescent-shaped and larger, expanding to roughly 50" by early March.)

As for **Mars**, well...

It's now in the western sky, about 20° above Venus in the southwestern sky as the year begins, and only 5½° from its showier counterpart towards the end of January. With a disk declining from 5.7" to 5.0" this month (roughly the same as the split between Castor's binary pair), Mars can be seen as a disk at high power, but that's about it. The planet will remain visible through the spring; by fall, it reappears as a morning object on the way to an advantageous opposition in 2018.

In the meantime, there's **Jupiter**—rising just before 1 AM at the beginning of January, it's past the Meridian before dawn. It's an easy target, too: bright at -1.9 magnitude, and 36" across. At the end of the month, Jupiter's disk is brighter and larger, at -2.1 mag. and 39"; by then, the planet will already be about 30° above the horizon by 2 AM.

Sky Calendar

5	First-Quarter Moon
12	Full Moon
19	Last-Quarter Moon
27	New Moon

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PRESIDENT'S MESSAGE

by Ron Hranac

State of the Society

2016 was another good year for Denver Astronomical Society. Here's a quick look at some of the highlights.

Year-over-year membership numbers continue to increase. As of early December, the count was 457, up from 428 at about the same time in 2015 and the high 300s in 2014. That's an encouraging trend, which hopefully will continue in 2017.

The University of Denver's Dr. Robert Stencel reported 3608 paid visits by the general public to DU's historic Chamberlin Observatory as of the end of November, down somewhat from about 4,000 at the beginning of December 2015. (Paid visits include our twice-weekly Public Nights, monthly Open Houses, and special events.) Skewing the 2015 numbers was a total lunar eclipse event at Chamberlin in September of that year, which added close to 400 to the year-end total. Excluding the 2015 eclipse, 2016 looks to be about even with the prior year.

The upgrades to the Public Night reservation system made in 2015, including automated e-mail reminders to folks who have made reservations, and an on-line pay-in-advance feature, turned out to be a positive move. The changes resulted in fewer no-shows and full or near-full bookings (Public Nights typically sell out several weeks in advance), a trend that continued throughout 2016. Average Public Night attendance has been in the 15-to-25 range per night, with several at or close to 30 each. A big thanks to Public Night coordinator Hugh Davidson, our Public Night team leads, and all of the Public Night volunteers.

Our external outreach program, headed up by Julie Candia, kept us busy last year. We averaged two to three events per month, during which members shared their love of astronomy by setting up 'scopes for daytime solar observing and nighttime star parties, and provided lectures and hands-on demonstrations at schools, museums, and other venues. When combined with Open Houses and Public Nights, figure 130 or more events reaching 5,000+ members of the public in 2016.

The finances of DAS are sound, and our bank accounts are in good shape. Look for a financial summary by Treasurer Mike Nowak during February's annual membership meeting.

The Van Nattan-Hansen scholarship awarded \$3000 to Matilyn Bindl, a student from Belvidere, Illinois. During her sophomore year of high school, she was presented the opportunity to earn both her high school diploma and her Associates Degree in Science. Matilyn plans to attend the University

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DAS SCHEDULE

JANUARY 2017

- | | |
|----|--|
| 7 | Open House—DU's Historic Chamberlin Observatory—Starts at 6:00 PM |
| 13 | DAS General Meeting—DU's Olin Hall, Rm. 105—Starts at 7:30 PM: Nomination of Officers and E-Board. |
| 20 | E-Board Meeting—At DU's Historic Chamberlin Observatory, 7:30 PM. All members welcome. |
| 28 | 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

DAS Leadership: E-Board Nominations

Denver Astronomical Society depends on many volunteers who do much, on a collective basis, to ensure the organization's success. Outreach is arguably the most important thing that we do, sharing our love of astronomy with 5000+ members of the public each year in our twice-weekly Public Nights, monthly Open Houses, and ongoing external outreach activities at schools, museums, and other venues. But a critically important volunteer role that often operates behind the scenes is the Society's leadership: Our annual elections are just around the corner, and we're looking for E-Board and officer candidates interested in a leadership

role with DAS. If you've thought about running for a position on the E-Board or would like to nominate someone, be sure to attend this month's general membership meeting at DU's Olin Hall on Friday, January 13th. Prior experience isn't necessary, just enthusiasm and a love for what we do. Nominations will open at the January meeting, and continue until the elections themselves at our annual membership meeting on Friday, February 10th. Elected E-Board members and officers will be officially seated at our spring banquet on Saturday, March 11th.



Volunteer Opportunities

January 2017, from 1:20-2:00 PM, TBD (would like a couple of days). Vanguard Classical School, 17101 E. Ohio Dr., Aurora, CO 80017. Question and answer session via Skype with an amateur astronomer. First-graders studying astronomy. (Fulfills requirement for online communication.)

January 26, 2017, starting at 6:00 PM: Home-schooled kids, Denver Metro (location TBD). Night viewing.

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



At February's Open House: How to Use a New Telescope

If you have recently acquired, or soon will acquire your first telescope, the Denver Astronomical Society can help you enjoy your 'scope and use it successfully. Please join us at DU's historic **Chamberlin Observatory Open House, on Saturday, February 4th, for a comprehensive talk starting at 7 PM. We will cover the basics, and more, of telescope**

set-up and operation, and give hands-on instruction. (You're welcome to bring your 'scope if you'd like.)

We will cover refractors, reflectors, and compound telescopes, the set-up and use of the finderscope and Telrad, and give tips on learning the sky, finding objects, and aiming at them. Other useful accessories will be dis-

cussed. (We'll touch on computerized, or "go-to," telescopes, too. If you need help with a computerized 'scope, we suggest you familiarize yourself with the instruction manual as much as possible ahead of time, and bring the manual with you.)



Dennis Cochran



On Sunday, December 18th, DAS President Ron Hranac, accompanied by members David Shouldice and Ivan Geisler, presented a Special Recognition Award to Dennis Cochran for his many years of service to the Society, including being a member of the E-Board and DAS Secretary, eight years of writing "The Skies" column in *The Denver Observer*, and his dedicated involvement in astronomy-related outreach. Dennis has moved to Southern California to live near family, and we will miss him.

Photo by Ron Hranac



BIG SCIENCE IN SMALL PACKAGES

By Marcus Woo

NASA Space Place

About 250 miles overhead, a satellite the size of a loaf of bread flies in orbit. It's one of hundreds of so-called CubeSats—spacecraft that come in relatively inexpensive and compact packages—that have launched over the years. So far, most CubeSats have been commercial

Much of the newly-released radiation from solar flares is concentrated in X-rays, and, in particular, the lower energy range called soft X-rays. But other spacecraft don't have the capability to measure this part of the sun's spectrum at high resolution—which is where MinXSS,



Astronaut Tim Peake on board the International Space Station captured this image of a CubeSat deployment on May 16, 2016. The bottommost CubeSat is the NASA-funded MinXSS CubeSat, which observes soft X-rays from the sun—such X-rays can disturb the ionosphere and thereby hamper radio and GPS signals. (The second CubeSat is CADRE—short for CubeSat investigating Atmospheric Density Response to Extreme driving—built by the University of Michigan and funded by the National Science Foundation.) Credit: ESA/NASA

satellites, student projects, or technology demonstrations. But this one, dubbed MinXSS (“minks”) is NASA’s first CubeSat with a bona fide science mission.

Launched in December 2015, MinXSS has been observing the sun in X-rays with unprecedented detail. Its goal is to better understand the physics behind phenomena like solar flares – eruptions on the sun that produce dramatic bursts of energy and radiation.

short for Miniature X-ray Solar Spectrometer, comes in.

Using MinXSS to monitor how the soft X-ray spectrum changes over time, scientists can track changes in the composition in the sun’s corona, the hot outermost layer of the sun. While the sun’s visible surface, the photosphere, is about 6000 kelvin (10,000 degrees Fahrenheit), areas of the corona reach tens of millions of degrees during a solar flare. But even without a flare, the

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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

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of Wisconsin-Madison to obtain her Doctorate in Astronomy or Astrophysics.

There weren't as many items consigned or donated for this October's annual auction as in past years, but most of what was brought to Chamberlin did sell. Still, that meant a smaller amount raised for the VNH scholarship fund compared to prior years.

We maintain a presence on social media, something we started a few years ago, in part to reach a younger demographic. We're on Facebook, Twitter, and YouTube. Our Facebook page had 1475 "likes" as of early December.

Our monthly general membership meetings at DU's Olin Hall feature top-notch speakers. We try to videotape meeting presentations and have uploaded some of them to our YouTube channel (<https://www.youtube.com/user/denverastro>) for those who can't make the meetings, for those who would like to see the presentations again, and for those with a general interest in DAS programs. Just the meeting videos on YouTube have been viewed nearly 25,000 times. If all of the videos we've posted are included, the viewing total is in excess of 40,000.

Digby Kirby took on a new volunteer position, that of New Member

Ambassador. He has made it a point to contact new members shortly after they join the Society. Digby is the go-to person for new (and not-so-new) members who have questions about DAS, its activities, and its benefits. Speaking of benefits, take a gander at my President's Message in the August 2015 issue of *The Denver Observer* for a quick summary (http://www.denverastro.org/newsletters/august2015_denverobserver.pdf).

A tip o' the hat to Leo Sack for stepping up to fill the role of Vice President late last year. Leo has also started an Open House learning area on the park lawn next to the observatory, where curious kids and grownups alike can learn to operate a telescope. Stop by and take a look!

Not only was 2016 a good year for DAS, it was a busy year. All of this and much more wouldn't have been possible without the time and commitment of dozens of volunteers. Thanks!



NASA Space Place

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corona smolders at a million degrees—and no one knows why.

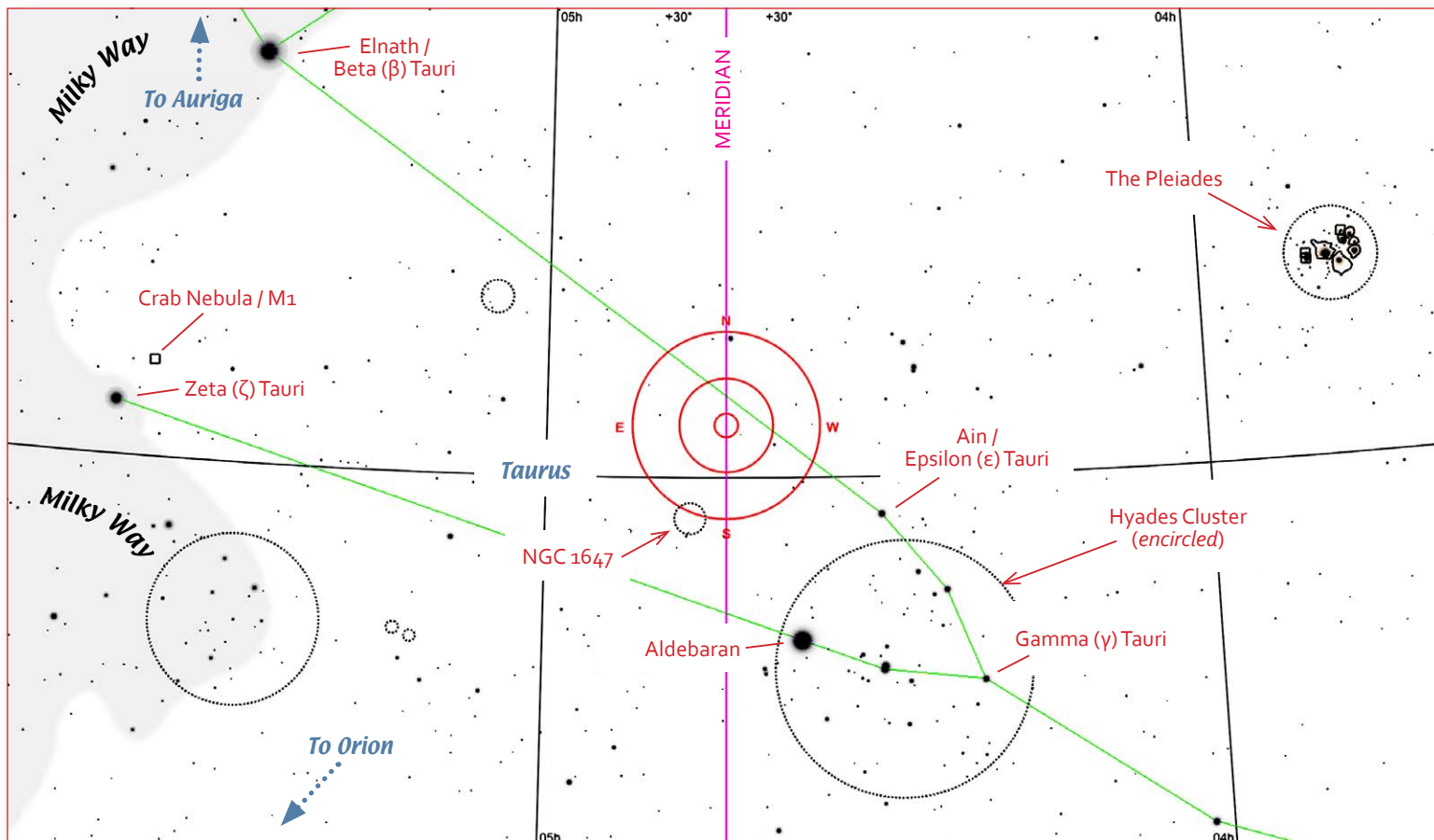
One possibility is that many small nanoflares constantly heat the corona. Or, the heat may come from certain kinds of waves that propagate through the solar plasma. By looking at how the corona's composition changes, researchers can determine which mechanism is more important, says Tom Woods, a solar scientist at the University of Colorado at Boulder and principal investigator of MinXSS: "It's helping address this very long-term problem that's been around for 50 years: how is the corona heated to be so hot."

The \$1 million original mission has been gathering observations since June.

The satellite will likely burn up in Earth's atmosphere in March. But the researchers have built a second one slated for launch in 2017. MinXSS-2 will watch long-term solar activity—related to the sun's 11-year sunspot cycle—and how variability in the soft X-ray spectrum affects space weather, which can be a hazard for satellites. So the little-mission-that-could will continue—this time, flying at a higher, polar orbit for about five years.

If you'd like to teach kids about where the sun's energy comes from, please visit the NASA Space Place: <http://spaceplace.nasa.gov/sun-heat/>





Viewing south and up in Denver at 9:00 PM in mid-January (10 PM early in the month, 8 PM late in month). Image center is about 70° up; Telrad included for reference.

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

January Skies

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Saturn is now a morning object, rising before Mercury in the eastern sky. While it's less than 10° up 30 minutes before sunrise as the year begins, that will improve to about 20° by February, and about 25° by March.

Looking further out into the solar system, **Uranus** still makes a convenient, not-quite-equilateral triangle with 5th-magnitude Zeta Piscium and 6th-mag. 88 Piscium in early January (it pulls away from those stars, making a somewhat less obvious pattern, by month's end). If you haven't observed Uranus lately, do so while you can—the 6th-magnitude planet already transits around 6:30 PM at the beginning of the year, and about 4:30 PM by February. On its way to superior conjunction this April, though, the giant planet has one more trick up its sleeve—a close conjunction with Mars on the 26th of February, when the two planets will appear just over a ½° apart.

Neptune begins its slide into the solar glare this month. Though still at a decent height as night falls in early January, it'll be only half as high, and sinking fast, by February—superior conjunction is March 1st.

Deep Sky

This month, along with a well-known supernova remnant, we've got two more open clusters—one that's right in front of you and very well known, and one next to it—that isn't! All three targets are in the constellation Taurus, the Bull.

Taurus owes a large part of its central "bull's head" V-shape to the brighter stars within the **Hyades Cluster** (also known as Melotte 25

or Caldwell 41). This bright, huge-looking open cluster, easily seen with the naked eye, spans more than 5° across our sky, and is centered roughly near **4h 30m, +16°**. Its extravagant apparent size, much too wide for most telescopes' fields, comes not from its physical dimensions, but from its *nearness*—just 153 light-years away.

Ironically, the "eye of the bull," and the brightest star here, Aldebaran, or Alpha (α) Tauri, isn't a member of the group—it's less than half the cluster's distance from us, at about 67 light-years. The other "eye," Ain, or Epsilon (ε) Tauri, *is* a member, and the brightest one, at that. Like the other bright members of the cluster, it's a yellow-orange giant—it's already used up enough of its hydrogen fuel to move past that phase of stellar life and start burning helium instead, swelling and brightening in the process.

According to Professor Jim Kaler, University of Illinois, Ain also happens to be the first star in an open cluster to have a planet discovered in orbit around it—it's a gas giant with more than 7 times Jupiter's mass, orbiting at an average distance of 1.9 astronomical units. At this distance, an observer near the planet could look back at Ain, and see its disk span more than 3° across the sky. We have this detailed information on Ain, and its cluster-mates, because of the Hyades' unusual proximity—close enough to measure Ain's angular diameter directly (the result agrees nicely with the size calculated from theory, using the star's brightness and spectrum).

Unlike most clusters, the best instrument for observing the Hyades is probably a good set of binoculars—or, from

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January Skies

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my point of view, your telescope's finderscope! (Even in the city, a 9x50 finder provides a lovely view—and because it's mounted on a telescope, the finder's view is *stable*.) Perhaps the biggest challenge in observing the Hyades is how easy it is to take it for granted—"If you don't have to point your telescope at it, well, maybe it's not a 'real' target." So, shake off that idea, point your finderscope at it the next time you're out, and enjoy a really close cluster!

If you're unfamiliar with the Hyades or the constellation Taurus, you'll find the bright orange star, Aldebaran lighting the way—it's about 67° up, or 2/3 the distance from the horizon to the zenith, when you face south at 9 PM in mid-January (10 PM at the beginning of the month, and 8 PM at the end). Look for the "V" to the right and upward of Aldebaran—it should be obvious under a dark sky. (To give you a sense of its size, the V is about half the width across the top of your knuckles when you hold your hand out at arm's length.) In the city, the V should be visible to the naked eye on a decent night—but poor conditions can easily wash it out.

Experienced observers also know that you can always find the V by looking first for the bright blue stars in Orion's belt (they're also high in the south in the winter). Just follow the direction of the belt stars from left to right (toward the northwest), and keep going about for about the distance across both hands' knuckles when you hold your arms in front of you. (By the way, continuing in the same direction about half-again that distance will take you to the Pleiades, another showpiece cluster.)

Our next object, the open cluster **NGC 1647**, at **4h 47m, +19° 08'**, lies some 1,800 light-years from us, and would likely be as wonderful to look at as the Hyades, if the former were 12 times closer! Instead, distance dims NGC 1647 by roughly 6 magnitudes—but it's still visible in binoculars or finderscopes under dark skies (try comparing it with the Hyades that way); its span of about 40 arcminutes also makes it a good target for low-power telescope fields. 1647 is just a few degrees northeast of the Hyades and easy to find, so it's worth a look for the comparison and, if you think about what you're looking at while observing, the *mental impression of depth*.

To get to NGC 1647, imagine the triangle with Aldebaran, Ain, and Gamma Tauri "flipped" across the Aldebaran-Ain line, so that the "mirrored" Gamma's new location would be to the northeast instead of the southwest—this new point would also complete a flat diamond shape when combined with the points of the original triangle. Aim your Telrad at this spot, and NGC 1647 will be about a degree from your finderscope's center.

Last up, something completely different—**M1, the Crab Nebula**, near the tips of the bull's "horns," at **5h 36m, +22° 01'**. I'm sure there are few experienced observers that haven't seen this vast cloud, but for our newer observers, this is one to have a look at. The nebula is the expanding product of a supernova explosion in 1054 A.D., an explosion bright enough to be seen here on Earth, naked-eye, *during the day*, for three weeks—and as it faded, for more than a year and a half at night. What's left of the progenitor star, Taurus X-1 (the designation means it's an X-ray object), lies about 6,300 light-years away—think how bright it must have been to shine for us in daylight, when our own Sun would require binoculars to see *at night* if it were in the Hyades, a "mere" 150 light-years away!

Taurus X-1 has also been identified as a pulsar (pulsating radio source) and as a 16th-magnitude variable star in visible light—for the

latter, it carries the designation, CM Tauri (the pulsating light curve matches the radio source in its timing). While you won't see the star itself in most amateur telescopes, its radiation interacts with and excites the gases in the Crab Nebula—this intricate, ionized cloud now spans more than 10 light-years across and glows at magnitude +8.4.

First-time observers are often disappointed when, after viewing astrophotos of M1 with delicate, swirling details, they only manage to see a gray, oval cloud. Fine filaments do become visible in large apertures (perhaps 12-16 inches) under very clear, dark skies—but seeing



The underlying structure of M1, the Crab Nebula, in a NASA image combining data from Hubble Space Telescope and Chandra X-Ray Observatory. Note the central ring-shaped X-ray shock wave pattern expanding outward into the cloud, and the jets aligned perpendicularly to the rings' plane.

X-ray Image: NASA/CXC/ASU/J. Hester et al.
Optical Image: NASA/HST/ASU/J. Hester et al.

them *still* wouldn't give you an accurate picture: X-ray images (above) reveal deep structure that even the Hubble telescope isn't sensitive to, so the Crab is an object that, even in large 'scopes, must be at least partly imagined—"seen with your mind," as much as seen with your eyes.

If you have a 50mm finderscope, center Zeta (ζ) Tauri, the tip of one of the bull's horns, in it to find M1—if it's a reasonably clear night, you might see a dim glow from the nebula in the finderscope, about 1° to the northwest from Zeta (just center the glow, and you're in). If not, imagine the line that runs between Zeta and Beta (β) Tauri (also known as Elnath, it's the tip of the other horn—and much brighter than Zeta). Start with your *Telrad* centered on Zeta, and slide it along your line to Beta, until Zeta rests on the *Telrad*'s 2° ("intermediate") circle—Zeta should now be on the opposite side from Beta in the *Telrad*. From here, "nudge" your 'scope gently about ½° (the diameter of the innermost circle) towards Aldebaran; that should put M1 in your telescope's low-power field.

— See you next month.



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 pre-

serve 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.

