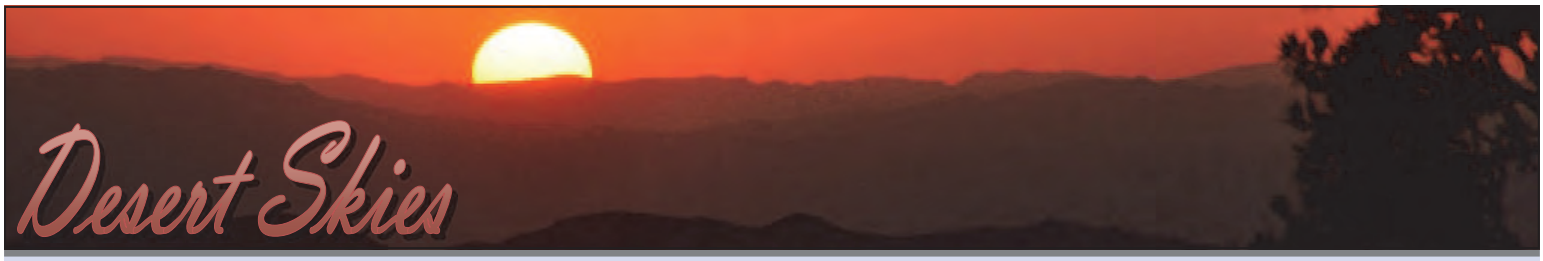

Tucson Amateur Astronomy Association

Observing our Desert Skies since 1954

Winter 2016 Volume LXI, Issue 4

Inside this issue:

Take Note!

- Grand Canyon Star Party Get Ready!
- CAC Update and Big News!
- Astronomy Services Report
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- Objects in Canis Minor
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- Determining Stellar Magnitude
- Viewing Black Hole Event Horizon

NGC 2170 in Monoceros

TAAA member Larry Phillips took this image (above) of NGC 2170. This is both a reflection (blue) and emission (red) nebulae and star birth area found in the constellation Monoceros (the Unicorn). The black streaks are absorption nebulae. This object is 2400 light years away and the image expands an area 15 light years across. © Larry Phillips. Used by permission.

Larry describes this as a hybrid image combining H-alpha images with regular RGB images. He has 38 hours of exposure in this image.

This area of Orion and Monoceros, contains a large molecular cloud known as R2 Mon to which NGC 2170 belongs and Barnard's Loop which encompasses much of Orion.

At right, an infrared image of the same object (different orientation). The infrared image penetrates the dark nebulosity revealing a stellar nursery.

For more information about this object, visit http://www.robgendlerastropics.com/NGC2170text.html.

Image: NGC 2170 as seen by VISTA (Visible Infrared Survey Telescope for Astronomy) reveals the secrets of the Unicorn. Credit: ESO

Our mission is to provide opportunities for members and the public to share the joy and excitement of astronomy through observing, education and fun. We fulfill this by providing Astronomy Services to schools, church groups, scout troops, and convention organizers. We support many organizations in the Tucson area that are involved in Science, Technology, Engineering and Mathematics (STEM) programs. Our members enjoy observing the night sky under the dark skies that our observing sites offer. We are an all-volunteer, tax-exempt, non-profit, 501(c)(3) organization.

Frequency

Desert Skies is published quarterly by the Tucson Amateur Astronomy Association, PO Box 41254, Tucson, AZ 85717.

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Desert Skies is published quarterly, near the dates of solstice and equinox. The deadlines for publication are March 1st, June 1st, Sept 1st, and Dec 1st. Submissions should be emailed to the editor at taaa-newsletter[at]tucsonastronomy.org. Submissions should be in the form of a text or Microsoft Word compatible file. Photos and artwork are encouraged. Please send these as separate attachments with resolution of at least 200 dpi (higher is preferred). Submissions are retained by the editor unless prior arrangements have been made. Copyrighted materials will not be accepted unless permission to use is clearly stated. We will not publish slanderous or libelous material. All copyrights retained by Tucson Amateur Astronomy Association, Inc. or the original author.

Contacting the TAAA

Editor: taaa-newsletter[at]tucsonastronomy.org

TAAA Board of Directors:
taaabod[at]tucsonastronomy.org

www.tucsonastronomy.org

520-792-6414

PO Box 41254, Tucson AZ 85717

From Our President

On behalf of the Tucson Amateur Astronomy Association, I would like to wish everyone a very Happy, Healthy, and Prosperous 2016! There is a lot to look forward to for TAAA as we move into the New Year. Our leaders and volunteers continue to go above and beyond to serve our members and community's interests, including School Star Parties, community events such as the Tucson Festival of Books, the Grand Canyon Star Party, Pubic Outreach, Education, TAAA Dark Sites, and many other areas. We should be proud of our efforts and look to continue to improve in 2016. I would like to highlight two areas of current achievement: our Chiricahua Astronomy Complex progress, the TAAA Web Site update, and the rework of the AFSIG's Introduction to the Fundamentals of Astronomy class.

As detailed in an article by John Kalas in this issue, TAAA has secured a donation of two fine telescopes, a 40" Dobsonian and a 13" folding refractor (with mount), as well as the funds to construct a nice concrete pad and adjacent building for housing the Dobsonian. In addition, we have achieved what we believe to be enough funds to complete the Large Rolloff Roof Observatory, which will house the 13" refractor along with other scopes. Look for a very exciting 2016 at CAC as construction ramps up! I want to commend the Strategic Planning Group for their diligent efforts that have produced such spectacular results for TAAA. We will surely have among the finest facilities of any astronomy club in the country when the CAC Master Plan is completed. CAC is intended for use by our members, so please consider making the trip this year.

Our Past President, Bob Gilroy, has been working with Diane Nuefeldt to completely revamp the current web site. The main expected benefit will be much improved user experience. We are moving towards a more standardized environment, with an eye to allowing for very timely updates to current information. The goal is to make the web site the preferred place to go for the most accurate, up to date TAAA information. Training classes for content owners begin in January with a projected site launch in March. Look for more information as we prepare to switch over to the new site.

So, as you see, we are starting 2016 with some very ambitious efforts to improve TAAA. Of course, with so much going on, we certainly can use more volunteer help! If you would like to pitch in there are many opportunities. Just contact any TAAA Board member or leader and join the team!

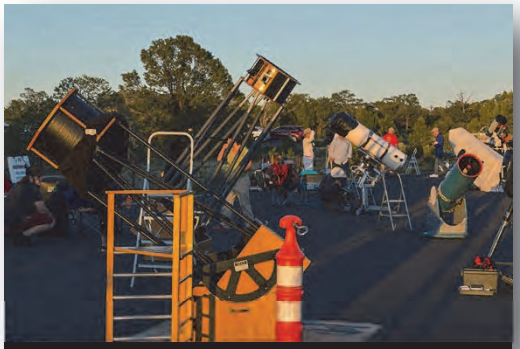
Ben Bailey

Community Involvement & Outreach

Now is the Time To Plan for Grand Canyon Star Party 2016

Text by Jim O'Connor, GCSP South Rim Coordinator (gcsp[at]tucsonastronomy.org) Photos by Bernie Sanden (unless noted)

The Grand Canyon Star Party is one of the jewels of the TAAA's community outreach program. Dates of the GCSP 2016 are June 4 through June 11. The Grand Canyon Star Party (GCSP) is a shared event between amateur astronomers and the National Park Service to bring astronomical outreach to visitors at the Grand Canyon. The GCSP takes place at the same time in two locations—the South Rim and the North Rim. The Saguaro Astronomy Club in Phoenix coordinates the North Rim activities, and TAAA coordinates the South Rim activities.



The GCSP 2015 Telescope Farm!

This will be the 26th year of TAAA coordinating this event. It was started and nurtured by Dean Ketelsen for the first 19 years and continued under my leadership for the last seven years. Over the GCSP's eight-nights, TAAA provides about a third of the volunteer astronomers, with the rest coming from all around North America, and in the past, Australia, England, France, and Russia.

Dennis Young, set up for solar observing along the Rim Walk.

The Summer Milky Way arches over the Grand Canyon Star Party 2015.

Each night on the South Rim behind the Grand Canyon Visitor Center, from 50 to 70 astronomers set up their telescopes for public outreach to show the night sky to park visitors. The astronomers act as interpretive rangers, explaining the night sky above the Grand Canyon to the visitors, just as Park Rangers explain the geology of the canyon during the day. Beginning in 2013, we began offering as many as seven live video-assisted astronomy setups to help make telescopes accessible to visitors with physical and/or optical challenges and for younger children who may have not yet developed the mental capacity to integrate an eyepiece image out of context.

Astronomer participants are formal National Park Service (NPS) volunteers. The astronomer Welcome and Information Package, sent to each volunteer, includes a NPS volunteer registration form and a form for tracking each volunteer's hours of service. These have extremely important functions; they quantify our value to the NPS and covers the volunteers for any medical or liability concerns. At night, park visitors tend to stop arriving by about 10:30 PM, and the Park Rangers take down the signs and path lighting around 11:30 PM, ending the official visitor support. The astronomers can then pursue their own observing

(Continued on page 4, GCSP)

Arizona Daily Sun

JOE ORR

By decree of the GCNP Superintendent, GCSP 2016 will be dedicated to Joe Orr to acknowledge his many physical and financial contributions to the environment and night skies at the Grand Canyon National Park, as well as his assistance to astronomy in other observatories in Arizona and Texas. More about Joe Orr, avid nature preservationist and amateur astronomer, can be found here:

http://azdailysun.com/news/local/obituaries/joseph-newton-orr/article_a3f3d6be-6452-11e3-a85b-0019bb2963f4.html

George Barber at GCSP 2015.

Some TAAA members who attended the GCSP 2015 (left to right): Mae Smith and her son Carter, Paul Lorenz, and Andy Keefer.

(Continued from page 3, GCSP)

desires, or pack up their equipment and rest up for the next day's activities. Many astronomers stay past midnight or 1 AM; we will always stay to service any visitors. General information can be found at our web site at http://www.tucsonastronomy.org/gcsp-2

2016 marks the 100th anniversary of the National Park Service, and is a special year for GCSP as well. The late Joe Orr provided significant funding for the beginning of the Grand Canyon Association's 2012 special project to reduce the light footprint of Grand Canyon National Park, but also, upon his untimely death in 2015, he bequeathed a tremendous additional amount to continue the project. As a result, it is expected that the GCSP astronomers will be participants in a Part 1 Approval Ceremony toward achieving International Dark Sky Park status in the near future.

Finally, our speaker list is already maturing. Dean Regas from the Cincinnati Observatory and co-host of the NPR Star Gazer show (replacing the late Jack Horkheimer) will give two of the night talks. We will also hear from Dr. John Barrentine, International Dark Sky Association Program Director. Chap Percival, a volunteer who was with us last year and a long time eclipse chaser, has written the inspirational book G*o See the Eclipse--and Take a Kid With You.* He will outline the August 21, 2017 total solar eclipse, especially in terms of how he involves children in the event. Details at http://www.goseetheeclipse.com

Park visitors are the reason we hold the Grand Canyon Star Party. During the day some of us will be scattered around the park at popular spots, showing bright planets, the Moon, or the Sun while talking up the night activities. The front of the Main Visitor Center, the Yavapai Geology Museum, and the areas around Maswick Cafeteria and the Canyon Café near Yavapai Lodge are all popular setup locations for daytime observing, as are areas along the Rim trails, for showing daytime terrestrial views.

The evening events are behind the main Visitor Center. Most of the telescopes need to be set up and taken down each night, but we have areas set aside for larger

(Continued on page 5, GCSP)

DEAN KETELSEN

Dean Ketelsen, shown here setting up his telescope for the public's enjoyment, is the founder of the current rendition of the Grand Canyon Star Party. Dean organized the GCSP for 19 years. John Dobson, well-known for the Dobsonian telescope design, along with the San Francisco Sidewalk Astronomers, were the first to make annual trips to the Canyon for a public star party.

Mike Magras at GCSP 2015.

(Continued from page 4, GCSP)

instruments and live video equipment which can remain set up during the day. After set-up, all vehicles are parked in an adjacent lot. Around 7 PM, we have a short gathering of astronomers and Rangers (referred to as the Popsicle meeting) to share any information. Activities begin with a night talk in the Visitor Center Theater just after sunset, around 8 PM. The theater has a maximum occupancy of 233, and we get 1400 or more visitors to the telescopes each night. Rangers or volunteer astronomers will also give constellation laser sky tours for those interested at 9:00, 9:30, and 10:00 PM.

For astronomer volunteers, registration with me is necessary so that I can send the Welcome and Information Package to you in May. It contains your entry documents and instructions for setting up and participating.

In general, astronomers are responsible for their own lodging. Lodging registration information can be found on our Accommodations link, http://tucsonastronomy.org/gcsp-accommodations-2/

Back side of El Tovar located at the South Rim of the Grand Canyon. Public Domain image.

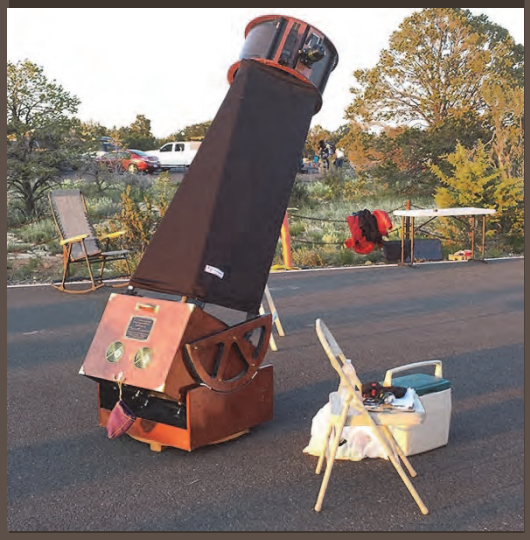
There are many options for lodging within Grand Canyon National Park. Non-camping lodging may fill up as early as late February, so make plans early. About half of the astronomers use Mather Campground, which costs around $20 per night, and provides primitive dry camping with showers and restrooms within walking distance. Next level up is Trailer Village, with full RV hookups available, at around $30 per night. "Hard housing" is available in many varieties, but can get scarce early in the year. Cabins include Bright Angel, very beautiful and near the Rim, the motel-like lodges of Maswick Lodge, Thunderbird Lodge, and Yavapai Lodge; and the crown jewel of the park, El Tovar, on the Rim. In the past, prices have ranged from around $90 a night at Bright Angel to over $300 per night at El Tovar. El Tovar, however, is generally booked a year or more in advance. By March it's difficult to reserve a lodge room for longer than one or two days in a row. My wife and I have been staying at Yavapai for the last 14 years and really like it. The cost has gone from about $100 a night ten years ago to $175 more recently. It is the most conveniently located hard housing—being about a mile and a half from the telescopes—and has most of the main conveniences co-located, such as the General Store, Post Office, Bank, souvenir shop, and two dining facilities.

Astronomers who volunteer for six or more nights of public outreach are eligible to request a complimentary camp site. The park provides us with a few sites as a benefit

(Continued on page 6, GCSP)

JIM O'CONNOR

Jim O'Connor has managed the GCSP at the South Rim for the past seven years. Above, he is doing what he loves—explaining solar physics to a visitor at his live video setup during the 2014 UA ScienceCity which takes place during the Tucson Festival of Books. Below, is his 18" Dobsonian telescope set up at the GCSP 2015. The GCSP is a family affair for Jim. Susan, his wife, helps out as well as a few of their grandkids. Contact Jim to participate in CGSP 2016. Contact information is provided at the top of this article in the by-line. (Top photo by Maria Schuchardt., UA LPL)



"You Never Know What One Life You'll Touch"

(Continued from page 5, GCSP)

to those who put in so much effort with the visitors. The sites can support two vehicles (anything with a license plate) and three tents. Since the demand is so high we assign two astronomer volunteers to each site. We will accept requests for these complimentary sites for those volunteering for six or more nights beginning March 1, 2016. We advise making alternative reservations earlier in the year, since the cancellation policy for paid lodging is only 48 hours. It doesn't hurt to have a backup.

Outside the park boundary is the town of Tusayan, which has many motels and lodges as well as restaurants and all the other features of a town. Tusayan is about 7 or 8 miles from where we set up. For this area, I recommend a web search on Tusayan Lodging. There is also a camping facility a mile or so from the park entrance, called Ten-X, run by the National Forest Service.

For astronomer volunteers and park visitors, the area around the Grand Canyon offers many attractions and activities in addition to the Park itself and the Grand Canyon Star Party. Flagstaff, Arizona is the home of Lowell Observatory with one of the best visitor activity programs in the world. Visit
http://www.lowell.edu/

Near Flagstaff is Sunset Crater, which erupted less than a million years ago, Wupatki National Monument (http://www.nps.gov/wupa/index.htm), and Lava River Cave in the Coconino National Forest. A bit further east are the Painted Desert, Petrified Forest, and Meteor Crater (actually, Barringer Crater). Visit
http://www.barringercrater.com/

The area around Page, AZ offers the Glen Canyon National Monument, Rainbow Bridge, and Antelope Canyon. Visit
http://www.nps.gov/glca/index.htm and
http://navajonationparks.org/htm/antelopecanyon.htm

If you have any questions or concerns, please ask. If you would like to be an astronomer volunteer, let me know so that I can get you the information package allowing you to register as a volunteer at the Park when you arrive.

Please plan to attend the 2016 GCSP which will indeed be a special event. Two of the last three years we've logged 70,000 visitor contacts, and, to quote a TAAA member, "You Never Know What One Life You'll Touch."

Can't make it this year?

GCSP 2017

June 17-24, 2017

Members' News

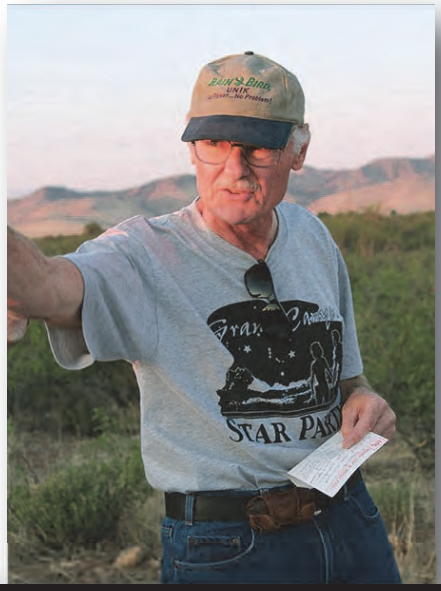
Astronomy Services—Year End Review

Text by John Kalas (mal3[at]tucsonastronomy.org)

Despite the decrease in business for 2015, the year-end results for the program were better than anticipated. The TAAA realized a total revenue of $6,705. from the program this year. Astronomy Service was provided to 25 events during the year; 14 for the JW Starr Pass Marriott Resort, 1 for the Ritz-Carlton Dove Mountain Resort, 5 direct bookings, 4 donation activities and 1 UofA complimentary event. I would like to express my appreciation to the following volunteers who contributed their time, gas and equipment during 2015:

Michael Turner (10 events)
J.D. Metzger (4 events)
Bill Lofquist (4 events)
Tom Rolfsmeyer (2 events)
Robert Wilson (1 event)
Bob Gilroy (1 event)
Jim O'Connor (1 event)

I will be retiring from the Astronomy Services coordination position at the end of this year, after serving for 17 years. Through the dedication of the volunteers who have supported this program over that period, the TAAA has received revenue totaling $128,381. I hope a replacement coordinator can be found to continue this worthwhile program.



We thank John Kalas for 17 years of service as our Astronomy Services Coordinator. Under his care, the program raised $128,381 for our programs, particularly the CAC observing site.

Winter 2016 TAAA General Meetings

TAAA Meetings
Location:
Steward Observatory
(933 N Cherry Ave)

Open to the public.

Date	Introductory Presentation (6:30 PM)	Invited Lecture (7:30 PM)
Jan 8	Mary Turner, PhD, TAAA Chief Observer Seasonal Objects	Michael Lesser, PhD, Steward Observatory Sensor Development at the UA Imaging Technology Lab
Feb 5	Jim Heasley, TAAA member Astrophotography	Brenda Frye, PhD, Steward Observatory Building Blocks of the Milky Way
Mar 4	TBA	Connie Walker, PhD, Nat'l Optical and Astronomy Obs. TBA

Upcoming Globe at Night Campaigns

January 1 - 10

February 1 - 10

March 1 - 10

http://www.globeatnight.org/

Chiricahua Astronomy Complex News

Inaugural CAC Star-B-Cue, Member Pad Construction Planned

Text and Photos By John Kalas, CAC Site Director (mal3[at]tucsonastronomy.org)

Photo by Alan Strauss

Much happened in 2015 at our Chiricahua Astronomy Complex. This is a review of recent additions.

Ramada

We had a very successful initial Star-b-cue under the new Ramada on Saturday, 10/10. Wally Rogers' new stainless steel gas grill was also inaugurated. The grill cart I designed worked fine in transporting the grill from its storage container to the Ramada and back.

Member Pads Area

On 10/13, Joe Jakoby, Glenn Summers, Ken Matesich, Paul Hoff and I surveyed and staked the perimeter of the 1.25 acres which required clearing. Construction has begun with the clearing and grading of the area just east of the Amphitheater container and pad. A review of the excavation work was planned for 12/10 prior to having a work party survey and stake out the locations of the ten electric pedestals required for the ten Member Pads to be installed.

Maintenance

The second 2015 application of pre-emergent was applied at the end of the year. This procedure should prevent winter weed growth due to a forecasted wet season and yield year-round weed control at the CAC Site.

The CAC Ramada now features four picnic tables. Come enjoy a picnic dinner before a night of observing

The CAC grill donated by Wally Rogers. Note John's handy cart for transportation

Ground cleared for construction of member pads at our Chiricahua Astronomy Complex.

Chiricahua Astronomy Complex News

An Exciting New Development at CAC

By John Kalas, CAC Site Director (mal3[at]tucsonastronomy.org) Photos provided by John Kalas

I would like to share an exciting new development for the Chiricahua Astronomy Complex (CAC). This activity will significantly enhance an already impressive site.

On 8/27/14, I received an e-mail from a gentleman by the name of Bob Reynolds of Houston, Texas. He stated that he was an avid amateur astronomer and was preparing to retire. Bob had on his "bucket list" the ownership of a large one-meter Dobsonian telescope. He already had a 40" Cervit mirror lined up at Lockwood Custom Optics in Philo, Illinois, and the telescope construction was assigned to Starstructure Telescopes of Hollywood, Florida. Bob's search for a location for his large telescope in the southern and southwestern U.S. led him to the TAAA website and this unbelievable opportunity unfolded.

One of the attractive aspects of the TAAA was our 501(c)3 non-profit status. Bob was retiring in 2015 and could benefit from a charitable tax deduction. He visited the CAC Site in late October 2014 and was very impressed with the facility. Bob became a member of TAAA in November 2014.

After some initial negotiations between Bob and the Strategic Planning Group (SPG), a decision was made to pursue this opportunity. SPG members Ron Probst, Joe Jakoby and I, together with Mr. Reynolds, developed two agreements which would define the responsibilities of both parties going forward.

Bob's original observatory concept was a 25'x25' roll-off roof design with a large 25'x25' adjacent warm room/control room. It soon became evident that an enclosed roll-off roof observatory was not the optimum observatory design for the telescope. Over the next year, the concept evolved into the final design shown on page 10.

An enclosed roll-off roof observatory was abandoned for a large 28'x30' open deck with the telescope permanently mounted in the approximate center of the deck. The telescope would be protected by a roll-off "shed" which would be stowed on a peninsular extension to the deck. Access to the eyepiece of the telescope would be facilitated by a large, roll-around safety ladder like the ones used in retail home centers to access upper warehouse racks. The warm room/control room grew from 25'x25' to 28'x25'. It will be heated and air conditioned and will also provide conference, training and meeting room capabilities. There will also be a small preparation area with a refrigerator and microwave/convection oven.

At one point, the observatory concept contained two additional roll-off roof observatories, one on each side of the warm room. When the design was ball-parked for cost, the high price tag resulted in these two additional observatories being deleted. Bob's interest in installing other telescopes at the site turned to the Large Roll-off Roof Observatory (LRoR) which was already under consideration by a working group within the SPG. At the time, TAAA Member, Wally Rogers, had a challenge grant for the LRoR Observatory on the table for $12,500. Bob offered to match Wally's grant and donate a fantastic equipment package for one of the piers in the observatory. The equipment includes a brand new Astro-Physics 1600 Mount and a one-of-a-kind 9" diameter folded refractor telescope. An appraisal of this equipment is currently being developed for tax purposes.

9-inch Folded Refractor on Astro-Physics 1600 Mount.

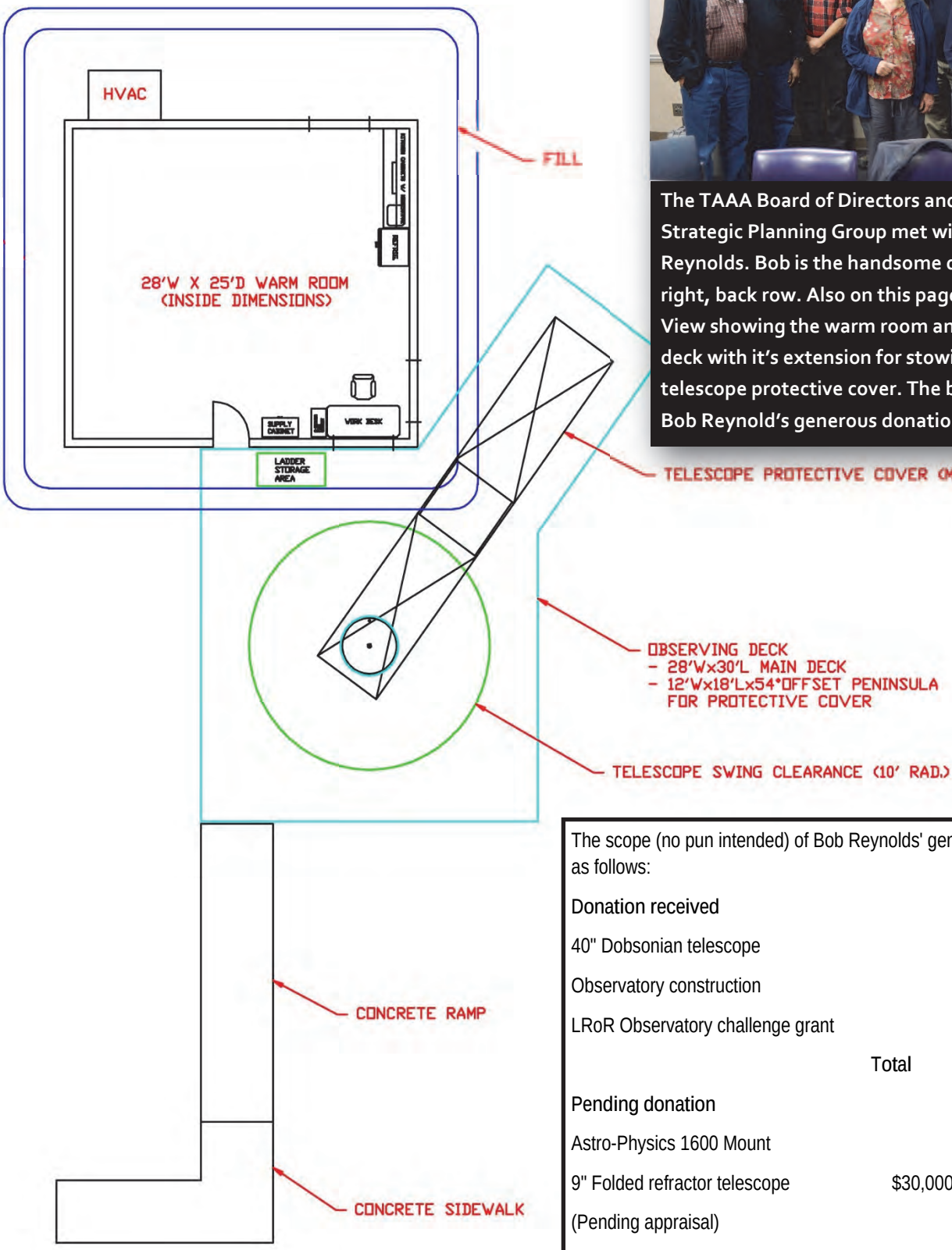
On November 7, 2015, Bob traveled to Tucson to attend a special combined meeting with the SPG and the TAAA Board of Directors to finalize "the deal". The agreements were reviewed, modified and updated. At the board meeting on 11/11, the TAAA Board of Directors approved the agreements and they were signed. Bob Reynolds delivered checks to the TAAA for fabrication of the 40" Dobsonian telescope, the construction of the observatory and the challenge grant for the LRoR Observatory.

Bob Reynolds requested that the observatory be named the Reynolds-Mitchell Observatory in honor of a very special person in his life. Mr. Earl Mitchell provided intellectual, financial and career support to young people he sensed needed only opportunity. In Bob's case, he gave him his first telescope and introduced him to a night sky that he would have never known existed. Bob is certain Mr. Mitchell would have appreciated the TAAA's goals and, further, he would have been honored to be associated with the CAC site and its effort to bring public access to a one-meter telescope.

The TAAA is deeply indebted to Wally Rogers and Bob Reynolds for their incredible generosity. The Reynolds-Mitchell Observatory and the Large Roll-off Roof Observatory will give the Chiricahua Astronomy Complex unprecedented equipment availability.

The Reynolds-Mitchell Observatory

The TAAA Board of Directors and the CAC Strategic Planning Group met with Bob Reynolds. Bob is the handsome dude at far right, back row. Also on this page is a Plan View showing the warm room and observing deck with it's extension for stowing the telescope protective cover. The breakdown of Bob Reynold's generous donation is below.



The scope (no pun intended) of Bob Reynolds' generous donation is as follows:

Donation received		
40" Dobsonian telescope		$87,500
Observatory construction		$100,000
LRoR Observatory challenge grant		$12,500
	Total	$200,000
Pending donation		
Astro-Physics 1600 Mount		$20,000
9" Folded refractor telescope		$30,000 - $40,000
(Pending appraisal)		
	Total	$50,000. - $60,000.
	Grand Total	$250,000. - $260,000

Featured Article

How did the ancient astronomers determine star brightness?

Text by Wayne Johnson (aka Mr. Galaxy) (mrgalaxy[at]juno.com)

Editor's Note: This originally appear on the TAAA Forum and appears with Wayne Johnson's permission

The human mind is an amazing if not targeted machine. Even while I'm concentrating on doing something which I thoroughly enjoy, like viewing celestial objects through my telescope, I'm constantly thinking about other things: some good, some weird, and some bad, as most people do. I like to think the majority of my thoughts are good and three of those trains of thought concentrate on: (1) how the ancient astronomers were able to determine the magnitudes of stars without modern techniques and instrumentation like photometers and very sensitive CCD imagers, which we have today; (2) the physics of how my telescopes and related equipment work while I am using them to do my astronomical observing (day and/or night); and (3) the history of astronomy, especially the discoverers of some of the objects which I view through my telescopes. Messier and the Herschels are certainly prominent among them, but there are over a hundred other observers who contributed to the major catalogs (like the New General Catalog - NGC) which we use today.

Finally, there is a good book on that topic (*Observing and Cataloguing Nebulae and Star Clusters: From Herschel to Dreyer's New General Catalogue*) by Wolfgang Steinecke, which I highly recommend. I've gone through the book so many times that the binding has broken!

Anyway, I have some ideas about how Hipparchus and Ptolemy (who borrowed and re-measured the positions of stars in Hipparchus' catalog a couple hundred years later) could have determined the brightness of stars without any sort of electronic instrumentation which was still about two millennia into the future. The telescope was about 1500 years in the future, too, as was accurate time keeping. What the ancient astronomers could accomplish in their time indicates the power of human intellect and the sensitivity of eyesight. I have never read or

Early astronomers Ptolemy (at left appearing with the Muse of Astronomy) and Hipparchus. The lower image of Hipparchus comes from a larger woodcut that appears on the title page of "The Cosmographical Glasse" by William Cuningham, published in 1559. Public domain images.

had access to any literature that spells out how such a feat could be done. Only 48 of the 88 constellations that we recognize today existed at the time of Hipparchus, who thrived around 175 BCE, about three centuries after the "Golden Age" of Athens.

One thing I don't know for certain is whether these feats were accomplished solely by the persons named above or if they worked with others as a team, as court astronomers, for some ruler. Did they earn their living by doing these tasks, or was this a sideline to their daytime job? It does seem that Hipparchus inherited the list of star positions from earlier Greek and Babylonian astronomers - again, what drove them to establish their list of star positions is a question we may never have answered. Ptolemy wrote a book which we know today as the Almagest and its ideas lasted for about 1500 years until scientists like Copernicus and Kepler came along. Maybe one of fourteen of Hipparchus' actual works still survive today. Otherwise we know of him mostly through the works of Ptolemy, etc.

It's fairly simple to order the brightness of objects like the sun, moon, Venus, and Jupiter in the sky because they wander and sometimes will be close to one another so that comparison is easily made. When you start getting to the brightest stars, with fairly fixed positions, it is not possible to compare and order them without some ability to "remember" how bright one star is when compared to another.

We have two powerful natural probes or tools, the Sun and the moon, that wander through our sky on a regular basis. They are bright enough to affect the detectability of the fixed stars. I suspect, like we have all done in our childhood, after sunset the ancient astronomers looked for the first star to appear each night. They probably didn't wish on them, but kept accurate records as to which stars appeared first and how long after sunset or before sunrise each

(Continued on page 12 Stellar Magnitudes)

(Continued from page 11, Stellar Magnitudes)

respective appearance occurred. The Sun moves about a degree on the sky each day so that a very small part of the sky is hidden or revealed for further inspection as days progress.

The moon is a unique object because, along with moving through the sky at a much more lively pace of about 13 degrees a day it also varies in brightness so that astronomers can see many dim stars when the moon is new or at a small crescent phase, but about a week before or after full moon only the brighter stars can be detected. The moon acts like a periodic, natural source of light pollution that makes it fairly easy to determine which stars are brighter than their neighbors, not unlike observing stars in our unnatural light-polluted cities. I suspect some of the early astronomers lived in major population centers, which had some level of light pollution from fires, etc., and that they could determine which stars were visible under those conditions, compared to being out under totally dark skies. The part of the sky affected by moonlight changes on a monthly basis, and it would be fairly easy for attentive ancient observers to follow certain stars and determine the brightness for each.

Planets like Jupiter and Saturn, I think, can also be used as "memory devices" to ascertain that certain stars are dimmer by some percent than these wandering objects, even though it takes these planets a decade or two, respectively, to tour the sky. Needless to say, like ancient observers, skywatchers today have to keep accurate records to pass on to their successors.

Once a map of the more prominent fixed stars' and their brightness has been constructed, fainter stars can gradually be added. Hipparchus re-determined the positions of about 900 stars known from earlier Greek and Babylonian observers, and found that their locations were consistently off by a degree or so, thus discovering the concept of "precession of the equinoxes" (the Earth wobbling like a top on its rotational axis) At the same time, he estimated their brightness to develop a concept known as stellar magnitude. Ptolemy added about 100 more stars to that amount, and in the process found that a number of these so-called "fixed" stars had moved by a larger amount, called "proper motion" (i.e., stars which are closer to us appear to move faster on the sky), from their original position. This wreaked havoc on preconceived ideas held by those who subscribed to an earth-centered (geocentric) idea of the Universe as it was known at that time. But that's a story for another time.

Classified Ads

Fantastic Items Here!

For Sale: Celestron 11" Schmidt telescope with mount and drive. $2500, cash. Very good condition. Included is stereo viewer, eyepieces, filters, battery pack, books, charts, and more in an accessory hard case. Contact Eric Schilling, Tucson, 520-370-3826, or speaksunrise@gmail.com

For Sale: Meade Nebula Filter $40; **The Night Sky Observer's Guide**—large, two volume hardbound set containing over 5500 celestial objects w/photos, descriptions and recommended sizes of binocular/scopes for viewing. $50; **Celestron HD Wedge adapter** for Astrophotography with select older Celestron telescopes, i.e. Ultima 2000, etc. $65 (cost $300 new). Contact Jim at 520-744-3858 or 520-401-6769

For Sale: Orion EQ-1 Tripod Mount w/EQ-1M Motor Drive & Hand Controller (complete system). Excellent for tracking objects using a smaller telescope and for DSLR astrophotography. As new, partially assembled. Manuals included. $95. If not sold, I am interested in compensating someone to complete the assembly for me. Contact Jim at 520-744-3858 or 520-401-6769.

Featured Article

How will we finally image the event horizon of a black hole?

By Dr. Ethan Siegel

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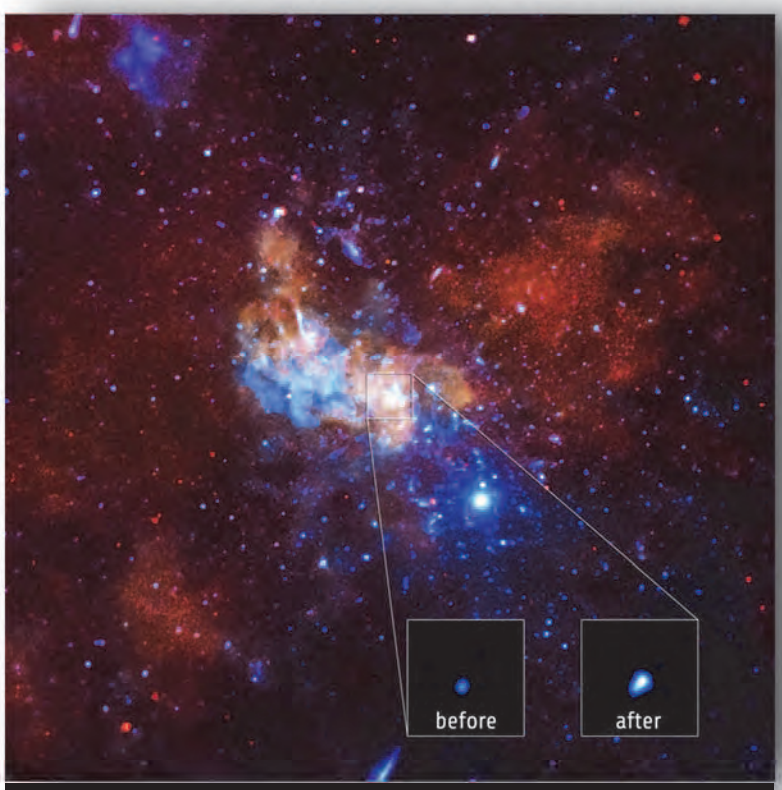

Image credit: NASA/CXC/Amherst College/D.Haggard et al., of the galactic center in X-rays. Sagittarius A* is the supermassive black hole at our Milky Way's center, which normally emits X-ray light of a particular brightness. However, 2013 saw a flare increase its luminosity by a factor of many hundreds, as the black hole devoured matter. The event horizon has yet to be revealed.

One hundred years ago, Albert Einstein first put forth his theory of General Relativity, which laid out the relationship between spacetime and the matter and energy present within it. While it successfully recovered Newtonian gravity and predicted the additional precession of Mercury's orbit, the only exact solution that Einstein himself discovered was the trivial one: that for completely empty space. Less than two months after releasing his theory, however, the German scientist Karl Schwarzschild provided a true exact solution, that of a massive, infinitely dense object, a black hole.

One of the curious things that popped out of Schwarzschild's solution was the existence of an event horizon, or a region of space that was so severely curved that nothing, not even light, could escape from it. The size of this event horizon would be directly proportional to the mass of the black hole. A black hole the mass of Earth would have an event horizon less than a centimeter in radius; a black hole the mass of the sun would have an event horizon just a few kilometers in radius; and a supermassive black hole would have an event horizon the size of a planetary orbit.

Our galaxy has since been discovered to house a black hole about four million solar masses in size, with an event horizon about 23.6 million kilometers across, or about 40 percent the size of Mercury's orbit around the sun. At a distance of 26,000 light years, it's the largest event horizon in angular size visible from Earth, but at just 19 micro-arc-seconds, it would take a telescope the size of Earth to resolve it – a practical impossibility.

But all hope isn't lost! If instead of a single telescope, we built an array of telescopes located all over Earth, we could simultaneously image the galactic center, and use the technique of VLBI (very long-baseline interferometry) to resolve the black hole's event horizon. The array would only have the light-gathering power of the individual telescopes, meaning the black hole (in the radio) will appear very faint, but they can obtain the resolution of a telescope that's the distance between the farthest telescopes in the array! The planned Event Horizon Telescope, spanning four different continents (including Antarctica), should be able to resolve under 10 micro-arc-seconds, imaging a black hole directly for the first time and answering the question of whether or not they truly contain an event horizon. What began as a mere mathematical solution is now just a few years away from being observed and known for certain!

Note: This month's article describes a project that is not related to NASA and does not suggest any relationship or endorsement. Its coverage is for general interest and educational purposes.

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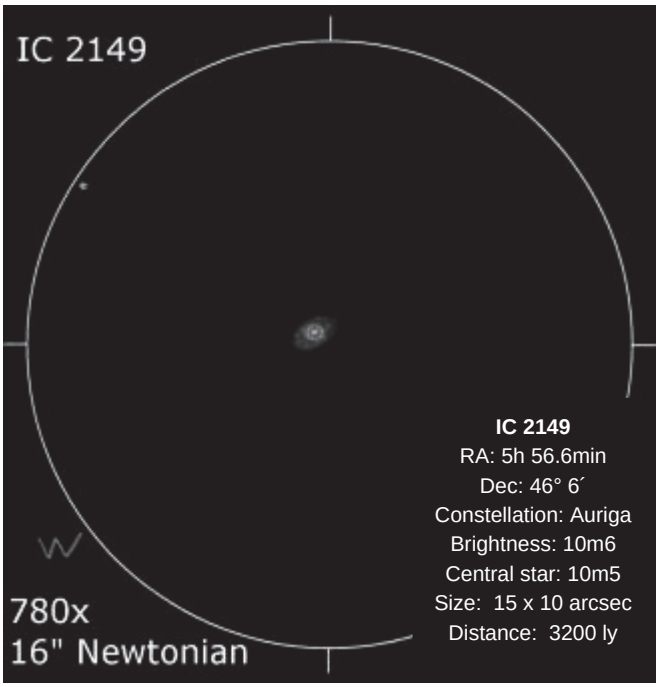
Observing and Imaging

Planetary Nebulae of the Quarter – Winter 2016

Text and Drawings by Christian Weis (weis[at]astroweis.de)

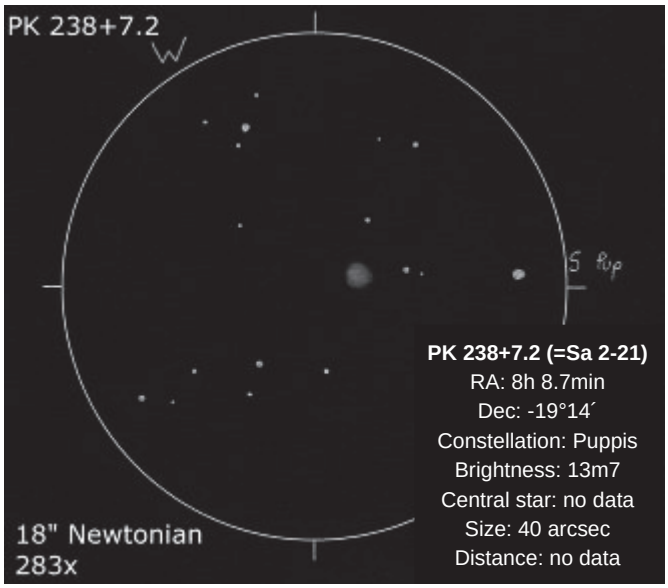
Planetary nebulae (PN) are fascinating objects which come in numerous forms or appearances. Besides the well-known grand four Messiers (M27, M57, M76 and M97), there are hundreds more to explore. This article suggests two PNs, a pretty bright and easy-to-observe one, and a harder one for the more ambitious observer who is equipped with a bigger scope.

Auriga is an eldorado for open star cluster lovers. But is it also for planetary nebulae observers? Well, it kind of is. There are at least 10 planetary nebulae located within this constellation, one of which is IC 2149. This object was discovered by Williamina Fleming in 1906. Mrs Fleming was one of few female astronomers of that era and was made the first female honorary member of the Royal Astronomical Society, also in 1906. With a brightness of 10m6, a 3" telescope should be able to show it – but one will need lots of power in order to discern a disk. IC 2149 is rather small, only being some 10 to 15 seconds of arc in diameter. I observed this PN with a 16" Dobsonian at Geology Vista, north of Tucson, in September 2010 and noted: Approximately 2:1 in E-W elongated, central star easy, center brighter and circular, halo weaker and elliptical, pretty small, mistaken for a star at 70x and 122x, diffuse, [OIII] helps a little; 780x, fst 6m3 (And)



Sandulaek 2-21 is a PN in Puppis that is rather unknown. What a pity, as this object is really neat! Steve Gottlieb points out that this object was found in 1975 by Nicholas Sandulaek which is quite "late" considering its brightness. George Abell must have missed it on the POSS plates. Furthermore, Sa 2-21 once was misclassified as a galaxy. I observed it in November 2014 with my 18" Dobsonian from a location close to my home in southern Germany and noted: Beautiful PN, at 94x using a filter it is already seen as an extended disk, S Puppis is disturbing and is best being placed outside the field of view, with higher power this planetary nebula can be seen without using a filter but is best seen using averted vision, UHC and [OIII] improve contrast a lot, however, there are no structures or a central star seen; 283x, fst 6m8 (Gem)

This object was my 200th planetary nebula – and it was well worth it!



Observing and Imaging

Planetary Nebulae with Cosmic Neighbors – Results

Text by Christian Weis (weis[at]astroweis.de)

In the spring 2013 issue of *Desert Skies Newsletter,* I presented a list of 14 planetary nebulae (PN) that have deep sky companions in close proximity and which are bright enough to be able to be seen with my 18" Dobsonian telescope from my location in southern Germany. I encouraged interested observers to participate – unfortunately to no avail. So, my old friend Frank Leiter (FL) and I (CW) were the only ones to submit observations. However, I have to add that I received positive feedback from a TAAA member who was happy to have a list of interesting objects for his public outreach program. I am glad to hear that the list is used.

In this article I present the results of this project as promised.

Observing strategy

It is advisable to first observe an object and to only then compare these observations with other observations or photographs. That way, a maximum of objectivity can be achieved. If anything, the apparent magnitudes and the apparent sizes can be known. Not until an object can not be seen or if doubts persist, further aides (e.g. ALADIN and SIMBAD) should be used.

Results

The following descriptions present the visual appearances of all objects in detail. Frank's observations took place before the list was created, so his focus generally was on the PN itself. Christian's observations were all conducted after compiling the list, so he focused on the simultaneous observation of both, the PN and their close companions.

Object 1 & 8: NGC 2438 / M 46 / PK 231+4.1

Right at the beginning, this is my personal favourite. All observers who successfully observed all Messier objects will likely know NGC 2438. It is the PN in the open star cluster M 46. While the open star cluster can be seen with the unaided eye on a reasonably dark location as a small hazy patch, it reveals its full magnificence in a mid-size telescope. Indeed, this would be sufficient to make for a nice observation. But there is more to come.

Studying the list in more detail one will find that NGC 2438 is listed on eighths place again.

There is another planetary close by – PK 231+4.1. This object is quite faint, though. With an apparent magnitude of 14m4, some aperture and an UHC or [OIII]-filter will be necessary. Also, some observing experience will be helpful.

FL: The planetary nebula in M46 can easily be seen with 56x in an 8" Dobsonian using a UHC-filter. Also, M46 and NGC 2438 are easy objects for a 3.5" refractor telescope. Inside the open star cluster the PN can be perceived with 102x. Employing a UHC-filter it is evenly bright and a generally circular disk. There is a star to the southeast of the nebula.

CW: M46 and NGC 2438 are wonderful. NGC 2438 is noticeably annular and very bright. Filters improve the contrast. PK231+4.1 is quite faint and can only be seen permanently when using a filter (UHC or [OIII]). Not before a magnification of 226x this object could be identified as a PN which appears as a tiny disk. Once the location is known, it can be seen star-like with 94x as well.

M 46 with Planetary Nebula NGC2438, by chance alignment.

Planetary Nebulae with Cosmic Neighbors

1. NGC 2438 / M 46
2. PK 38-3.2 / PK 38-3.3
3. PK 107-2.1 / NGC 7423
4. PK 52-4.1 / PK 51-3.1
5. PK 43+11.1 / NGC 6635
6. PK 21-0.1 / NGC 6649
7. NGC 6543 / NGC 6552
8. PK 231+4.1
9. IC 1295 / NGC 6712
10. PK 210+1. 1 / Biur 10
11. NGC 246 / NGC 255
12. PK 103+0.2 / NGC 7261
13. PK 89-0.1 / IC 1369
14. NGC 1535 / NGC 1538

Object 2: PK 38-3.2 / PK 38-3.3

This constellation of two PNe is quite interesting. From 14 entries in the list there are only three pairs consisting of PNe – at least at first glance, because this pair does not exist at all!

F.L.: not observed

C.W.: The seemingly fainter object PK 38-3.2 could easily be identified at the 18" Dobsonian equipped with a filter. But where is its companion? After a longish search using different filters I thought to have found the right candidate – quite a bright stellar object (significantly brighter than the designated 13m6) that I believed showed a slight brightening compared to other stars in the FOV when inserting a filter. A following test with a blazed grating, however, revealed that this object must be a star. PK 38-3.3 was not found.

ALADIN was of no help, either, showing a mark at empty space. I then aborted the observation.

(Continued on page 16, PNs with Neighbors)

(Continued from page 15, PNs with Neighbors)

Afterwards, I tried to find out what was wrong. At SIMBAD, PK 38-3.3 is listed as "not a PN" and "misclassified PN: several stars". A paper by Lubos Kohoutek from 2001 states exactly that. The misclassified star is BD+03 3946 with an apparent magnitude of 10,3 mag at RA 19h14m24.1s and DEC +03°33´55´´.

Well, those things happen – especially when observing off the beaten paths. And this is one of the things that makes astronomy so fascinating for me.

One does not necessarily need a big telescope, in this case a 6" would have sufficed to find out. And there is one more truth one is faced with: Astronomical catalogs are not flawless.

Object 3: PK 107-2.1 / NGC 7423
F.L.: At 225x PK 107-2.1 attracts attention by its strong response to [OIII]. It is easy to blink and to identify this object. Within seeing, the PN appeared stellar in this night. NGC 7423 was not specifically looked for and did not stand out.

C.W.: The planetary nebula is only just visible and can be identified with the filter blink technique. It remains stellar. NGC 7423 is big but has a low surface brightness. Two stars in the open star cluster stand out but the cluster remains diffuse. It is elongated 1:1.5 north to south.

Object 4: PK 52-4.1 / PK 51-3.1
F.L.: PK 52-4.1 appears stellar-like at 400x that shows a good response to [OIII] and that can be identified easily using the filter blink technique. The neighboring object PK 51.9-3.8 is located at the right angle of a right triangle. It can be identified with an [OIII]-blink at 145x and appears a little expanded at 400x, a little bigger than a star's disk of comparable brightness. At times of above-average seeing the small expansion can be verified. Furthermore, the view can best be described with a visible central star.

C.W.: Very nice „double blinking planetary", so two stellar PNs in one FOV. Both objects can easily be seen without filter and be identified with filter blinks. Both show good response to [OIII] and UHC but remain stellar within the seeing limitations up to a used maximum magnification of 452x.

Object 5: PK 43+11.1 / NGC 6635
F.L.: not observed

C.W.: The galaxy NGC 6635 can be seen immediately with averted vision at 94x, but is relatively faint. At higher magnification the core appears a little brighter, from time to time a little elongated in SW-NE (unsure), PK 43+11.1 is extremely difficult to identify since filters and the blazed grating would not help. I could identify the correct object not before checking with ALADIN; altogether, this object constellation is rather unspectacular.

Object 6: PK 21-0.1 / NGC 6649
F.L.: not observed

C.W.: The open star cluster is very bright and easy, with averted vision it appears completely resolved with no involved nebula; the PN is at the limit of visibility, after a long search I found it using SIMBAD, only at 94x using a filter I could see a slightly extended object; at higher magnifications the filters are too dense, even without a filter the PN cannot be seen better; PK 21-0.1 remains a toughie

Object 7: NGC 6543 / NGC 6552
F.L.: At first glance, a green shining and elliptical disk appears without using filters. A very bright central star is located in this disk . With filter a well defined ellipse which is surrounded by a faint halo appears at 225x. NGC 6552 was not specifically looked for.

C.W.: NGC 6543 is very bright and appears green, the central star is extremely conspicuous; structures can even be seen without using a filter; with filter IC 4677, an extension of the planetary nebula, is also visible. NGC 6552 is significantly fainter but can still be seen using direct vision, however, averted vision helps a lot.

Object 8: M 46 / PK 231+4.1
see object 1

Object 9: IC 1295 / NGC 6712
This object was the trigger for this article. At an observation under virtually perfect skies in the Austrian Alps I stumbled across this nice pair while "strolling" through the milky way. Since both objects are pretty bright, they are also suitable for apertures as small as 6". A UHC-filter improves visibility of nebulae.

F.L.: The PN IC 1295 can already be seen at 92x without any filter and appears as a very big, circular object. Brightness distribution among the surface is irregular. The globular cluster NGC 6712 is resolved up to its center at 225x.

C.W.: The globular is very bright and noticeably extended and "cornered"; the bright center is surrounded by a fainter "halo" which is bigger to the north-west; the PN itself is rather faint but blossoms out when an [OIII] or UHC is inserted. Then a circular patch appears which is similar in size as the globular; it becomes fainter towards the outer regions; no central star, with an inserted [OIII] filter, both objects appear similarly bright

Object 10: PK 210+1. 1 / Biur 10
F.L.: The PN can already easily be seen at 156x without filter as small but extended object. Increasing power does not reveal more structures. The PN appears as a circular disk without a central star, even at high power. Using an [OIII] filter does not reveal more details. The open star cluster did not attract attention.

C.W.: Biur 10 is a small open star cluster that at 94x appears nebulous with some 7 directly visible stars, increasing power to 283x reveals some 12 to 13 stars, the cluster, however, remains kind of nebulous.

PK 210+1.1 can be identified using the filter blink technique at 94x; it is not very bright but still visible with direct vision; the PN remains stellar

Object 11: NGC 246 / NGC 255
F.L.: not observed

C.W.: The galaxy NGC 255 can be seen easily, it is quite bright and diffuse; at 94x there is no brightness gradient, higher magnifications reveal a slight gradient; the planetary nebula NGC 246 is superb, it has a significant ring structure; at 94x there are four stars embedded inside the nebula, at 283x five, among those is the central star; along a streak in the west the nebula is significantly brighter, also, it is brighter in the north and the south compared to the east, [OIII] and UHC improve contrast; NGC 246 is about equal in brightness as NGC 255.

There is a surprise in the FOV for the attentive observer: In the outer northwest there is a small

(Continued on page 17, PNs with Neighbors))

(Continued from page 16, PNs with Neighbors)

diffuse spot which does not disappear at higher magnifications. It cannot be resolved into stars and shows no response to any filter at all. Already at the observation, I suspected a galaxy. Further research using SIMBAD and ALADIN confirmed this. Indeed, at the indicated spot the faint (14m5) galaxy MCG-02-03-009 is located

Object 12: PK 103+0.2 / NGC 7261
F.L.: not observed

C.W.: The open star cluster NGC 7261 is not very conspicuous and consists of only a couple stars of different brightness in the shape of a box. The object is completely resolved and does not contain any nebula. A fainter group of stars in the east first lead me to believe that this is the correct star cluster; PK 103+0.2 was only seen doubtfully, only at 94x and using an [OIII] filter while making use of the field-sweeping technique I was able to see a faint glow at the right spot at around 50% of the time

Object 13: PK 89-0.1 / IC 1369
F.L.: not observed

C.W.: Even though IC 1369 is obvious, I first misinterpreted an M-shaped asterism to be the open star cluster; the object consists of a dozen or so directly visible stars, with averted vision the cluster appears nebulous; the PN is only visible with filter, it is significantly extended and uniform in brightness; at 94x I cannot say if there is any elongation, at 161x I would tend to 1:1.5 in E-W (insecure); at 226x a faint star appears in the nebula but I do not believe that it is the central star; the difficulty is to compare the position of the star that can only be seen without filter to the position of the nebula that can only be seen with filter

Object 14: NGC 1535 / NGC 1538
F.L.: Already at 92x, the bright and extended central region of NGC 1535 is visible, it is surrounded by a fainter outer shell. The significant greenish color can be distinguished. The central star was seen at 225x without any doubt. Increasing power to 400x reveals a "frayed" edge of the inner shell, only to segments keep their well-defined edge. The diameter of the inner shell is around half as big as the outer one. NGC 1538 in the neighborhood did not attract attention.

C.W.: NGC 1535 is very bright and reveals an extended disk, with averted vision the PN is brighter towards its center; it has a fainter shell and appears circular in shape.

NGC 1538 is very faint and could not be seen before going to 226x. At this magnification NGC 1535 is not in the same FOV any more. Once the position of the galaxy is known, it can be seen at 94x and averted vision. There is a dot-like brightening at the north-east of the galaxy.

Reducing power to 64x leads to a disappearance of NGC 1538.

ASP Skywatchers: Astronomy Picks for All Ages

Kids' Launchpad

Each month the ASP will include one activity for your family to do together. Learning about the moon, stars, planets and the universe around us, is more fun when you can do it together. We have provided explanations and activities appropriate for both younger children and their older siblings.

Astronomical Society of the Pacific
Advancing science literacy through astronomy

Younger sisters and brothers (Under 8 years old)

Here is a fun and humorous video to watch together that will help explain the changes in the seasons using the "plastic globe of science" as presented by Bill Nye, the Science Guy. We hope that this will inspire your family to get creative with modeling the seasons and celebrating the solstice in a way that is meaningful to you.

Older sisters and brothers (8 years and older)

The solstice is hard for children to visualize and even harder to explain without a good model, this month we are encouraging you to look for images online, read this comic strip together, and then have your children create their own comic. Try this cool online tool.

If you have fun with these activities, take pictures and have your kids write or videotape an explanation of the activity in their own words. We would love to see their results! You can send them to acaryl@astrosociety.org

Kids' Launchpad is provided complements of the Astronomical Society of the Pacific. Visit www.astrosociety.org to learn more about the ASP and visit the ASP AstroShop (ASP members get discounts on most items.)

Observing and Imaging

Constellation of the Season: Canis Minor - The Little Dog

Text and artwork provided by Chris Lancaster

The Constellation of the Season was written by Chris Lancaster and is the basis of his book, "Under Dark Skies - A Guide to the Constellations, Trafford Publishing (http://bookstore.trafford.com/Products/SKU-000158114/Under-Dark-Skies.aspx). While the information was accurate at the time of the original writing, the reader should be aware that the sky does change over time. In particular, separation and position angles of double stars may have increased or decreased. This article is presented as originally written. Consult current observing resources for correct separations and position angles. ©2008 Used by permission.

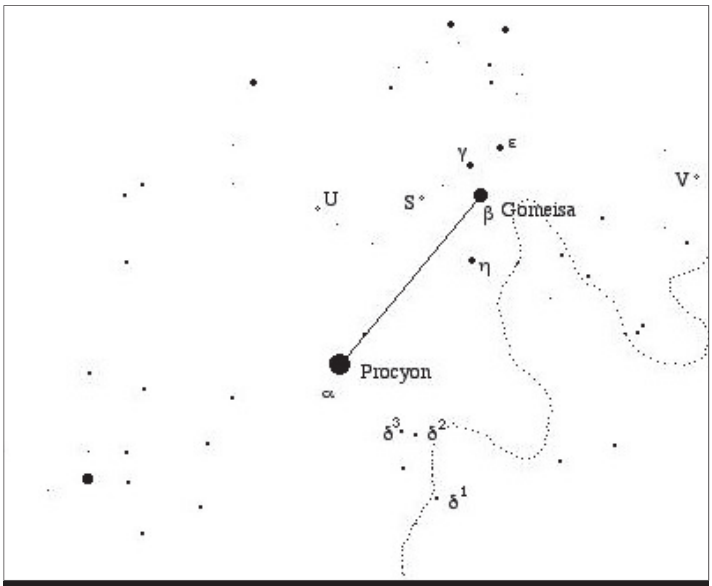
The other, less conspicuous hunting dog of Orion is found south of Gemini and on the opposite side of the winter Milky Way from its companion, Canis Major. The bright star Procyon marks the heart of the constellation and forms the northeast point of an equilateral triangle with Orion's Betelgeuse and Canis Major's Sirius. Canis Minor, as its name might suggest, is a small constellation. It encompasses only two bright stars but, even though it lies on the edge of the Milky Way, no deep sky objects.

Procyon's magnitude is a bright 0.4, making it the 8th brightest star in the sky. Its distance of 11.4 light years ranks it as number 13 of the nearest stars to Earth, and 5th nearest of the naked eye stars. Other vital statistics include a spectral type a bit hotter than the sun at F5, a luminosity of about 6 times the sun, and a diameter approaching 2 million miles, or over twice that of the sun. The name Procyon comes from the ancient Greeks. It translates "before the dog," since it rises mere minutes before the real dog star, Sirius. Because of its proximity, Procyon has a comparatively large proper motion, or movement relative to more stationary background stars. Its annual motion is 1.25" toward the southwest, which means that it will traverse a full degree in about 2,900 years.

Beta Canis Minoris, or Gomeisa, is a hot B7 star 170 light years away. Gomeisa is a much brighter star than Procyon, but appears dimmer from its larger distance. If equally placed relative to the Earth at the standard distance of 10 parsecs, or 32.6 light-years, Procyon would glow at magnitude 2.7, while Gomeisa would shine much more brightly at -1.1.

Similar to Sirius, Procyon has a dim white dwarf companion about 4.7" distant at a PA of 78 degrees. It was predicted to exist in 1861 due to the 40 year cycle of irregularities in the proper motion of Procyon, but because of the extreme differences in luminosity (Procyon B is 15,000 times fainter at magnitude 11), it was not visually observed until 35 years later through the 36-inch refractor at Lick Observatory. If you've been successful at observing the companion of Sirius, then you might want to try this one. However, Procyon B is a little more challenging with over a full arc second less separation.

Two other double stars of Canis Minor share this characteristic of large luminosity differences. Eta Canis Minoris at high power shows a



Canis Minor

magnitude 5.5 primary and a magnitude 11 secondary 4" apart. Nearby Gamma is a more comfortable 30" apart but presents a more challenging secondary. It shines at magnitude 13 compared to the primary at magnitude 4.

Canis Minor is also home to some dramatic variable stars. All of them are classified as Long Period Variables, or LPV's. The three we will look at are all in a west to east line in the northern half of the constellation. U (RA 7h 41m 20.7s Dec +08d 22' 50") goes from a moderate 8th magnitude to a practically invisible 13.8 over a period of 413 days. U is 44' northeast of a 7.1 magnitude star, which itself is 2.7 degrees due north of Procyon. Look 2.1 degrees due west of U (or hop 46' southeast from Gamma to a star of 7.1 magnitude, and then another 30' in exactly the same direction) for S Canis Minoris (RA 7h 32m 42.8s Dec +08d 19' 07"). Here we see a star which fluctuates between 6.6 and 13.2 magnitudes during a 332 day period. On the extreme western edge of the constellation is V, a similar variable which goes from 7.4 to 15.1 over 366 days. This star is 5.2 degrees due west of Gamma (RA 7h 06m 58.8s Dec +08d 52' 41").

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Astronomy Services Coordinator	Bill Lofquist	520-297-6653	astronomy-services[at]tucsonastronomy.org
Apparel Sales Coordinator	Mae Smith	520-850-7137	taaa-sales[at]tucsonastronomy.org
Boy Scout Liaison	Joe Statkevicus	-	boyscout-liaison[at]tucsonastronomy.org
Equipment Loan Coordinator	OPEN		elc[at]tucsonastronomy.org
Librarian	Hunter Bailey	-	librarian[at]tucsonastronomy.org
Grand Canyon Star Party Coordinator	Jim O'Connor	520-546-2961	gcsp[at]tucsonastronomy.org
Introductory Lecture Facilitator	Al Anzaldua	520-409-5797	introductory-lecture-scheduler[at]tucsonastronomy.org
Invited Lecture Scheduler	Terri Lappin	520-977-1290	terrilappin[at]tucsonastronomy.org
Calendar Designer	Susan O'Connor	520-780-0136	calendar-designer[at]tucsonastronomy.org
AL Correspondent (ALCOR)	Paul Anderson	520-625-5035	alcor[at]tucsonastronomy.org
Chief Observer	Dr. Mary Turner	520-743-3437	chief-observer[at]tucsonastronomy.org
Astro-Imaging Special Interest Group (SIG)	Jim Heasley	520-268-8586	astro-photo[at]tucsonastronomy.org
Astronomy Fundamentals SIG	Dennis McMacken	520-638-8178	fundamentals[at]tucsonastronomy.org
Starry Messenger SIG	Terri Lappin	520-977-1290	smsig[at]tucsonastronomy.org
General Information	Chuck Hendricks	520-247-3815	taaa-info[at]tucsonastronomy.org

TAAA Publications Committee: Terri Lappin (chair), Eric Allen, Louise Good, Karen Liptak, Twila Peck, Richard Schulze, John Struve