

The High Desert Observer



April 2016



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The Astronomical Society of Las Cruces (ASLC) is dedicated to expanding public awareness and understanding of the wonders of the universe. ASLC holds frequent observing sessions and star parties and provides opportunities to work on Society and public educational projects. Members receive the *High Desert Observer*, our monthly newsletter, plus membership to the Astronomical League, including their quarterly publication, *Reflector*, in digital or paper format.

Individual Dues are \$30.00 per year

Family Dues are \$36.00 per year

Student (full-time) Dues are \$24.00

Annual dues are payable in January. Prorated dues are available for new members. Dues are payable to ASLC with an application form or note to: Treasurer ASLC, PO Box 921, Las Cruces, NM 88004. Contact our Treasurer, Patricia Conley (treasurer@aslc-nm.org) for further information.

ASLC members receive electronic delivery of the HDO and are entitled to a \$5.00 (per year) Sky and Telescope magazine discount.

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March Meeting --

Our next meeting will be on **Friday, April 22**, at the DACC Main Campus, Room 141, Technical Studies Building, starting at 7:00 p.m.

The speaker will be Dr Guy NcOgersib
Topic: Abrupt Climate Change.

ASLC Board of Directors, 2016

Board@aslc-nm.org

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Treasurer: Patricia Conley; Treasurer@aslc-nm.org

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Outreach: Chuck Sterling; csterlin@zianet.com

Web-Site: Steve Barkes; steve.barkes@gmail.com

HDO Editor: Charles Turner; turnerc@stellanova.com

Member Info Changes

All members need to keep the Society informed of changes to their basic information, such as name, address, phone number, or email address. Please contact Treasurer@aslc-nm.org and jkile3916@gmail.com with any updates.

Outreach

Outreach is a very important part of ASLC. We are always looking for more volunteers to help us educate the public. Even if you do not have a portable telescope to bring to the events, please consider attending our public outreach programs to help answer questions, share knowledge and point out constellations in the sky.

Events

ASLC hosts deep-sky viewing and imaging at our dark sky location in Upham. We also have public in-town observing sessions at both the International Delights Cafe (1245 El Paseo) and at Tombaugh Observatory (on the NMSU Campus). All sessions begin at dusk.

At our Leasburg Dam State Park Observatory, we hold monthly star parties. Located just 20 miles north of Las Cruces, our 16" Meade telescope is used to observe under rather dark skies. Please see *Calendar of Events* for specific dates and times.

From the Prez

April 2016

Coming Soon to an Astronomy Club Near You!

In the spirit of making things fun and interesting by joining the ASLC, members are working together in producing activities that would appeal to a wide variety of interest in astronomy.

On April 22nd, Bob Kimball will have a workshop on processing astro-images with the program PixInsight. Although this workshop is directed to those who are already experienced in astro-imaging, it is open to anyone who has an interest in this topic and would like to get an appreciation for how wonderful images of the cosmos are made. Bob's workshop will be from 5:30 pm to 7 pm in room 141 of the DACC main campus.

Next month, on May 14th, we will be celebrating Astronomy Day at Leasburg Dam State Park. Members Bob Kimball and Tony Levatino will be having a presentation on astro-imaging, bringing attention to this very interesting and rewarding aspect of astronomy. There will be solar observing, courtesy of the NMSU Department of Astronomy, and during the evening Dave Doctor will be at the observatory for observations of the Moon, Jupiter and more. There will also be a presentation on the exploration of the Moon and Jupiter.

During Astronomy Day there will also be a quiz contest for a chance to win a beginner astronomy binocular set and/or a beginner telescope set. To be eligible, participants need to receive a study guide before May 11th. Anyone 9 years of age and up, interested in a beginner telescope or binocular, can participate. To receive a study guide send a request to president@aslc-nm.org.

Apart from the astronomy, there will also be live music and a presentation with live birds of prey. So, even if you are not planning to bring scopes or have a presentation on an astronomical topic, come with your family and friends and enjoy a day with us exploring the Solar System and beyond.

For those who are novices in astronomy, later in May or in June, there will be an outdoor workshop at Leasburg Dam State Park on learning your way around the night sky using a planisphere. Date and times to be determined. So please stay tuned.

Also, for novices, around early July there will be a workshop at Leasburg Dam State Park for learning how to select a telescope for beginners and how to use them along with their accessories. Date and time to be determined.

I am working on tours of the VLA in September and of the Magdalena Ridge Observatory, sometime this year. Once I get final confirmation of dates I let you know about the details.

From time to time, members will be announcing observing opportunities at various locations. Take the opportunity to join them, even if you don't know your way around the night sky. The others will be happy to show you around.

So, if you have something you would like to teach others about or conduct activities that will interest other members, please put it out for all to know. Likewise, if there is anything you would like to learn about and a workshop on that topic would be useful, let us know.

Working together, we can make membership in the ASLC fun.

Daniel Giron, Jr.

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Outreach Events
by Jerry McMahan

Leasburg, Saturday, March 22,

This was a special event set up of the Mayfield High School Airforce ROTC cadets. It was nearly a full Moon and the wind was terrible, but the students seemed to have a good time and many of the expressed interest in coming to more of our events, included the regular Leasburg open house on April 2.

Chuck Sterling, Ed Montes, and I set up scopes near the Observatory to get some protection from the wind. I had the 8 inch, Chuck set up his 10 inch and Ed was using his little 50mm refractor. That scope did a great job on the Moon and took the Blue Ribbon for cutest telescope. Sid Webb was also present with a scope and Dave Doctor opened the observatory for people to see the 16 inch. The roof of the observatory was not opened due to the wind.

It was great to have John Kutney join us. He set up a computer just outside the building and let people see images and demonstrate the capabilities of his software.

University Hills Elementary School, Thursday, March 31

As far as I know, this is the first time we set up at this school. It was scheduled to be from 5:30 PM to 7:30. Since it was not yet dark by the end time, this was set up as a Solar observing event. The problem was, when we arrived it was cloudy, the wind was blowing, and it was raining. We decided to demonstrate the scopes inside with the rest of the school's science exhibits.

After we set up, it cleared up. Chuck Sterling moved his 100mm refractor, with a white light filter outside. Sid Webb joined him with a hydrogen alpha scope. I stayed inside to demonstrate the goto capabilities of the ETX 125. I pretend observed Jupiter, M42, and Polaris. Tracy Stuart was also inside with me. He had his 90mm Orion Maksutov and showed people what the exit sign looked like in the scope. He also had a white light filter and eclipse glasses to explain how to observe the Sun in a safe manner.

Leasburg, Saturday, April 2

Dave Doctor ran the observatory. Ed Montes, Sid Webb, Christina Lugo, Daniel Giron, Chuck Sterling and Jerry McMahan also participated. Rich Richins did a Messier Marathon with Emma.

Several days before consisted of high winds, clouds, and wind, but this did not feature any of those negatives. It was clear with no wind. Groundhog Phil lied, however. It was cold. The observing sessions went very well. There were some Cub Scouts present and they participated in Daniel's quizzes. It was a pretty successful night.

Sunrise Elementary School, Thursday, April 7

This was supposed to be a Solar event since it would end before getting dark. The problem was that it was cloudy and the position of the Sun was not even obvious. There was no way we would be able to see anything. Chuck Sterling, Tracy Stuart and myself did show up anyway. We at least demonstrated that we were there to attempt to fulfill our obligation.

We had a couple, that have been coming to our events and to some meetings, stay the entire session. They were a lot of help. They can't make the next meeting, but plan to be at the one after it.

We looked at the Moon, and had our first Moongaze view of Jupiter, which cleared the building just before 9 PM.

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Calendar of Events (Mountain Time - 24 hr. clock)

Apr	02	19:30	Dark Sky Observing at Leesburg Dam State Park
	05	02:17	Jupiter: Double transit, Io and Europa (Jup = +42° Alt)
	07	05:24	New Moon
	07	18:00	OUTREACH; Sunrise Elementary School (Solar)
	11	18:30	OUTREACH; Tombaugh Elementary School
	12	04:35	Jupiter: Double transit, Io and Europa (Jup = +06° Alt)
	13	21:59	First Quarter Moon
	15	19:30	NMSU: Tombaugh Observatory Open House
	16	19:30	OUTREACH; MoonGaze, International Delights Café
	21	23:24	Full Moon
	22	19:00	ASLC Monthly Meeting; DACC Main Campus, Room 141
	29	17:30	OUTREACH; Sunrise Elementary School (Solar)
	29	21:29	Last Quarter Moon
May	01	09:00	Texas Star Party Begins: May 1 to May 8
	06	13:30	New Moon
	06	22:39	Jupiter: Multiple Moon transits(not simultaneous), Io, Europa & Callisto(Jup=+64°Alt)
	09	09:00	Mercury Transits the Sun: Greatest Transit about 09:00 -Last Contact 12:40
	13	11:02	First Quarter Moon
	13	20:00	NMSU: Tombaugh Observatory Open House
	14	13:00	OUTREACH; Astronomy Day at Leesburg Dam State Park
	14	20:00	OUTREACH; MoonGaze, International Delights Café
	21	15:13	Full Moon
	22	05:00	Mars at opposition
	27	19:00	ASLC Monthly Meeting; DACC Main Campus, Room 141
	29	06:12	Last Quarter Moon
	30	00:00	Memorial Day - All Day
	30	16:00	Mars closest to Earth; apparent size = 19 arc sec

Be sure to visit our web site for the latest updates: www.aslc-nm.org

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Announcements

April's ASLC speaker is Dr. Guy McPherson. The topic will be Responding to Abrupt Climate Change. Dr. Guy McPherson is professor emeritus of natural resources and the environment at the University of Arizona, where he taught and conducted research for twenty award-winning years. His scholarly work, which has for many years focused on conservation of biological diversity, has produced more than a dozen books and hundreds of articles. He is a renowned public speaker.

His presentation will discuss how Earth is in the midst of abrupt climate change. The ongoing phenomenon has precedence, including a 5° C global-average temperature rise in 13 years about 55 million years ago. The attendant loss of habitat for our species represents a tremendous existential threat to Homo sapiens.

John Gilkison reported on the meeting with the City of Las Cruces regarding LED lighting. "We had a successful follow up meeting with the CLC on the LED lighting question on the 28th of March. The city has agreed to limit all residential lighting to 3000 K LED street lights in future installations. They have not begun retrofitting any of the 4,000 fixtures for residential areas yet, and probably will not begin doing so until late this year or early next year.

They have already installed about 600 of the 3,563 main arterial roads street lights and they indicated they would like to keep the energy savings in these fixtures which amounts to at least 4% for 4000 K over 3000 K lighting. We explained that the energy efficiency for these lights was more apparent than real on a lumens basis, given the spectral sensitivity of the human eye.

My rough calculations show that this agreement we have negotiated with the City of LC will avoid the emissions of over 20 billion lumen hours of light per year which has the potential to preferentially back scattered to the night sky. This is quite a coup, and sets a good precedent for dark sky work.”

ED- Kudos to John Gilkison for spearheading this very important effort.

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Meeting Minutes
by John McCullough

Minutes, March 2016 ASLC Meeting

Show & Tell:

There were no informal presentations prior to tonight’s meeting.

Call to Order:

Daniel Giron, President, Astronomical Society of Las Cruces (ASLC), called the March 2016 business meeting to order at 7:34 pm., 18 March 2016, Room 141, Doña Ana Community College, Las Cruces, New Mexico.

President’s Comments:

Daniel Giron, President, welcomed the group to tonight’s meeting and noted that this month’s meeting is being held a week early because of DACC’s Spring Break. Daniel asked that all members be sure to check in on the roster and visitors and guests sign the guest list and that all present register for door prizes to be presented at the conclusion of the meeting. He then asked if all members had received the latest edition of the Society’s newsletter, the High Desert Observer (HDO), had a chance to read the February meeting minutes and if there any were any comments, issues, or concerns. Noting none, he asked for approval of the February minutes as published in the HDO. Kim Morgan moved for approval, Robert Armstrong seconded, and the February minutes were approved by acclamation.

Treasurer’s Report:

The Treasurer, Trish Conley, reported on the status of the Society’s various accounts and noted that she had paid the liability insurance premium. There was no additional Treasurer’s report.

Committee Reports:

Outreach Committee:

Chuck Sterling, Outreach Coordinator, reported on pending events. A star party will be held at Leasburg Dam State Park (LDSP) for Mayfield High School Air Force Junior ROTC students on 22 March (23 March will be a bad weather backup), 7:00-10:00 pm. The monthly public event at LDSP will be on 02 April. Star parties will held at University Hills Elementary on 31 March, Sunrise Elementary on 07 April, and Highland Elementary on 29 April. Because of Daylight Savings Time, these elementary school events will be mostly solar-viewing events. The Tombaugh Observatory Open House will be 15 April. The Moon Gaze at International Delights Café (IDC) will be 16 April. Members can check the yahoo group for details and to volunteer.

Tombaugh Observatory:

Steve Shaffer, Committee Chairman, was not at tonight's meeting. Jerry MacMahan reported that there were fifty-seven (57) visitors at the Open House on 11 March. Additional volunteers are always needed and welcome, especially at the AFROTC event at LDSP.

Astronomy Day 2016:

Daniel Giron announced Astronomy Day will be observed on 14 May at LDSP (also a Moon Gaze at IDC). Volunteers are needed for anything/everything astronomy-related to demonstrate or display. Daniel is working on publicity for the event. The Friends of LDSP are sponsoring singer Allison Reynolds, there will be horn pizza, and a raptor presentation. New Mexico State University (NMSU) students may partner with the Society for this event and there may be participation by the Museum of Nature and Science. Contact Daniel if you can help.

There were no additional committee or officer reports.

Old Business:

1. PixInSight – Robert Kimball will conduct a workshop lasting approximately 1-½ hours on using PixInSight as opposed to PhotoShop on 22 April. Bob passed around a reminder sheet for those that had indicated interest in learning more about the software. He said he has always appreciated the astro images posted on Society members' websites and on the imagers' yahoo group. Chuck Sterling noted that images are also posted on the ASLC Face Book page.

2. Speakers – Speakers are still needed for September and October. A potential speaker for one of those meetings is an archeologist/historian from White Sands Missile Range. Guy McPherson will make the presentation on 22 April (Earth Day).

3. Star-B-Que – Mary Alba, Walter Haas' (Society founder) daughter, has offered to host a star-b-que at her home northeast of Las Cruces for the Society. The potential date is 15 October. Cristina Lugo coordinating this with Mary.

There was no additional old business discussed.

New Business:

1. Observatory Tours – Daniel is working with the Very Large Array (VLA), Apache Point and Magdalena Ridge (MRO) observatories for potential behind-the-scenes tours for Society members.

2. Beginning Astronomers Support – Workshops are being planned for new astronomers including topics on choosing a telescope and basic astronomy.

There was no additional new business for discussion.

Items for Sale:

Jerry Gaber has some observing equipment he is selling. A list and suggested prices are on the sign-in table. He will negotiate.

Announcements:

The family of Society Founding Member, Cecil Post, is hosting a reception on Sunday, 10 April 3:00 pm. at 4225 Senna in Las Cruces. They are donating Cecil's telescopes and other observing equipment to the Society for outreach and education Daniel Giron will attend to represent the Society. Please contact Daniel if you would like to attend.

Recognitions/Achievements:

There were no recognitions or achievements announced at tonight’s meeting.

The business portion of the meeting was adjourned at 7:53 pm.

Presentation:

This month’s presentation was by New Mexico State University (NMSU) Astronomy graduate student, Kyle Uckert, on “The Search for Life”. Kyle is completing his final year as a NASA Space Technology Research Fellow PhD candidate in Dr. Nancy Chanover’s research group in the Department of Astronomy at NMSU. His dissertation topic is on the characterization of biosignatures in subterranean rocks using a suite of in situ instrumentation techniques. He has also participated in other research projects, including the optimization of mass spectrometers for the detection of organics, the development of a portable IR spectrometer, the analysis of a stellar occultation by Neptune, and an evaluation of the solar system observing capabilities of the James Webb Space Telescope.

Kyle spoke about his dissertation research on the detection of microscopic lifeforms in caves using a portable infrared spectrometer developed at NMSU. He described the relevance of caves on other planets and solar system objects for the search for life in the universe, the scientific instruments that may be implemented to find microbes in caves on Mars, the development and testing of an IR spectrometer at NMSU for life detection, and the robotic exploration of caves, including the field test of a cave climbing robot in a lava tube in New Mexico.

In appreciation of Kyle’s presentation, Daniel presented him with a Curiosity Rover medallion.

Door prizes – Member: Chuck Sterling, a book, “Traveler’s Guide to Mars”.
Guest: Mary Payle, a book, “How to Live on Mars”.

The March meeting of the Astronomical Society of Las Cruces concluded at 8:45 pm.

-Respectfully submitted by John McCullough, ASLC Secretary

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Back at the Telescope

by Bert Stevens

Supernova explosions should occur in our galaxy about once every fifty years. We do not see anywhere near that rate of production, so there must be supernovae explosions happening behind thick clouds of dust and gas that block our view of their demise. With the addition of infrared telescopes, we have been able to find some of these supernova remnants behind those dust clouds.

Before the invention of the telescope, these rare “guest stars” would appear in the sky without warning. Only the supernova that became brighter than sixth or seventh magnitude would be seen. All of these supernovae were in our galaxy.

After the invention of the telescope, supernovae started to be discovered in other galaxies. The rate of discovery was slow, but eventually dedicated supernova discoverers, checking the same galaxies repeatedly, would find a supernova. They would then report it to the astronomical community.

Initially, the reporting would occur through word-of-mouth and letters written to other observatories announcing the discovery. After the invention of the telegraph, the Central Bureau for Astronomical





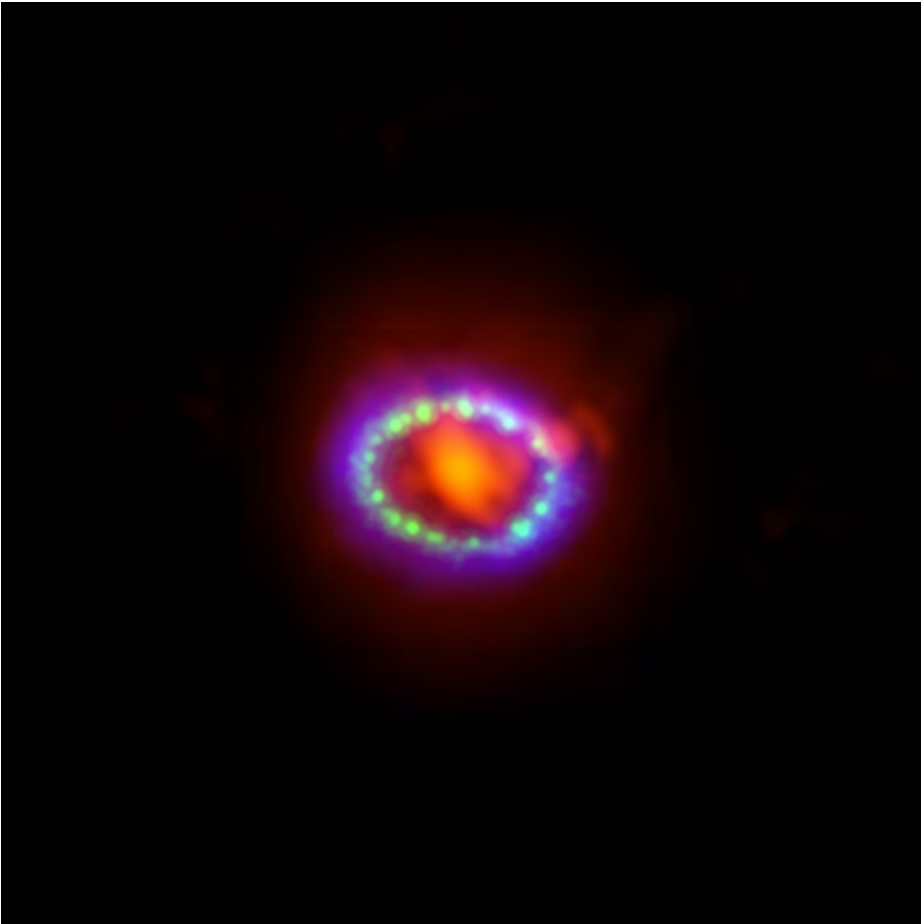
Supernova 1994D

The almost edge on galaxy NGC 4526 hosts Supernova 1994D. This Type Ia supernova was discovered by R. R. Treffers, A. V. Filippenko, S. D. Van Dyk, and M. W. Richmond. The object was found March 7, 1994 using the automated 30-inch telescope at Leuschner Observatory near Berkeley, CA. (NASA-HST Image)

Telegrams (CBAT) was founded by Astronomische Gesellschaft in 1882 at Kiel, Germany. World War I forced it to move to the Østervold Observatory at Copenhagen, Denmark, where it was operated by the Copenhagen University Observatory.

The Harvard College Observatory (HCO) started the western hemisphere version of the Central Bureau in 1883. In 1965, the CBAT moved from Copenhagen to the Harvard College Observatory and merged with the existing service. This made HCO the focal point for the announcement of astronomical discoveries, including supernovae, to astronomers all over the world.

While human-based discovery of supernovae continued to bring more of these events to light, astronomers were working on automating the process. Computer controlled telescopes and CCD cameras would allow the automated system to observe hundreds of galaxies a night. The image of each galaxy would be compared to a reference image of the galaxy. If anything was different between the two images, an alarm would be raised and an astronomer would check the anomaly to see if it was a supernova.



Composite of Supernova 1987A

Supernova 1987A is a Type II supernova discovered in the outskirts of the Tarantula Nebula in the Large Magellanic cloud on February 23, 1987. It reached a peak magnitude of around three in May. Supernova 1987A was discovered by Ian Shelton and Oscar Duhalde at the Las Campanas Observatory in Chile. Newly formed dust in the center of the remnant is shown in red (radio data from ALMA). The Hubble provided visible-light data shown in green and Chandra provided x-ray data in blue. Both show the expanding shockwave from the explosion.

One reason for an anomaly might be a minor planet that has entered the field. Astronomers added computer code to check each anomaly to see if it is a minor planet. Even so, it could be an undiscovered minor planet, so a single image does not

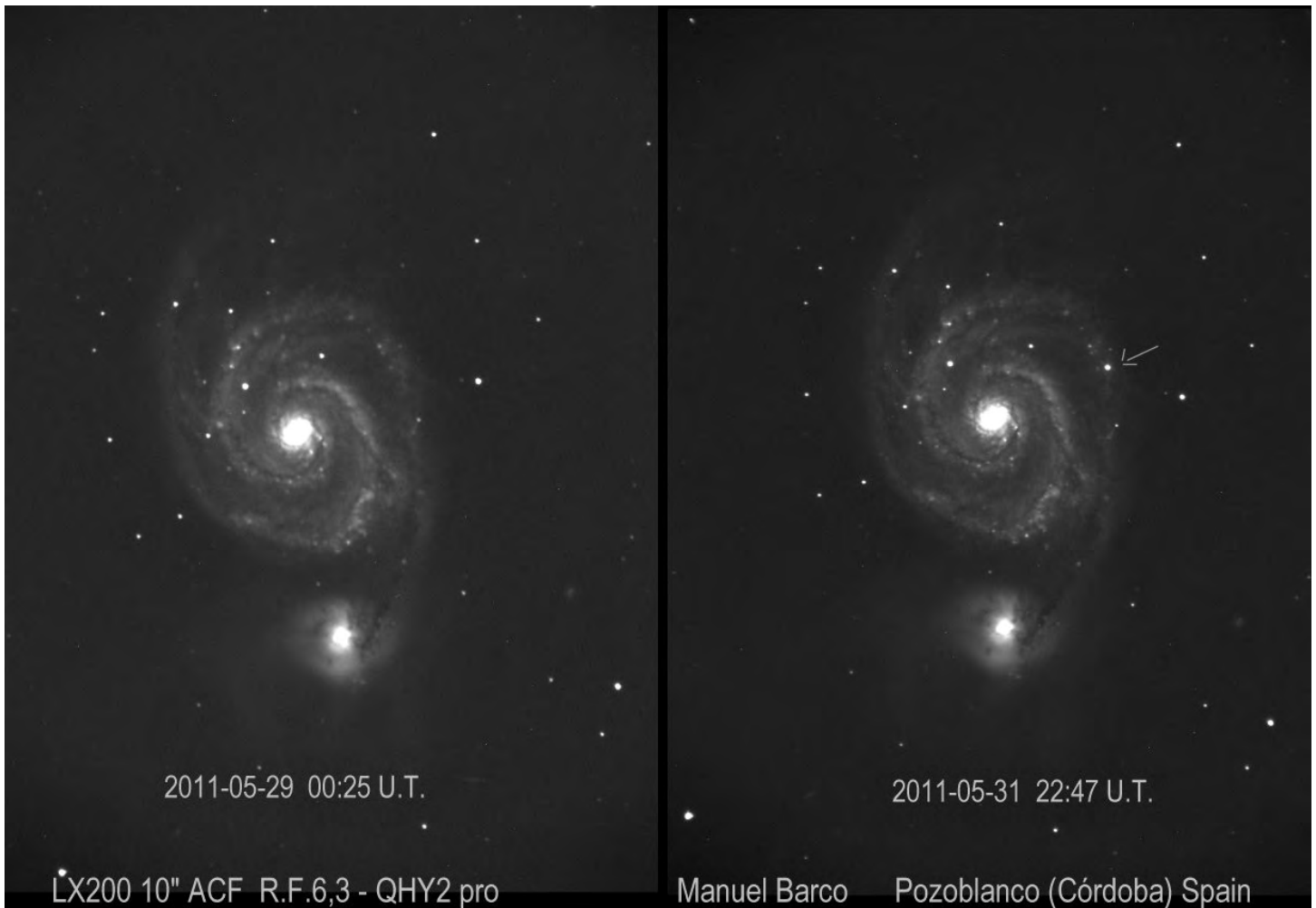
make a supernova discovery. Another reason for an anomaly might be a cosmic ray strike on the CCD detector, creating a false “star”. A confirming observation that there really is a new “Optical Transient” (OT) in this location is required before the object can be announced.

The Web has allowed the Central Bureau to expand their services with the CBAT Transient Objects Confirmation Page (<http://www.cbat.eps.harvard.edu/unconf/tocp.html>). This web page allows astronomers to announce an object to be confirmed. The first column indicates the object type proposed by the discoverers. PSN designates a Possible SuperNova. PNV indicates a Possible NoVA. Everything else, like variable stars or unknown objects, are designated TCP.

While seeing the OT in multiple exposures, especially over a period of a day or two, confirms the OT exists, exactly how to classify OT takes a spectrogram. A large telescope is usually required to get enough photons to be able to spread them out into the spectrum of the OT. This spectrum usually allows astronomers to classify the object into the broad categories of supernova, nova, or variable star.

Supernovae come in many different flavors. The two major classifications are Type I and Type II. Type I supernova start as white dwarf stars that are pulling material from a companion star. As the material (primarily hydrogen) accumulates on the surface, the added weight compresses the core of the white dwarf, heating it up. When the temperature reaches a critical level, nuclear fusion of carbon and oxygen resume in the white dwarf’s core.

With nuclear fusion restarted in the core, the dwarf gets hotter and hotter. In its final seconds, the white dwarf’s core starts converting carbon and oxygen into heavier elements, releasing so much energy that the heat overcomes the star’s gravity, blowing it apart in a Type Ia supernova explosion.



Supernova in M 51

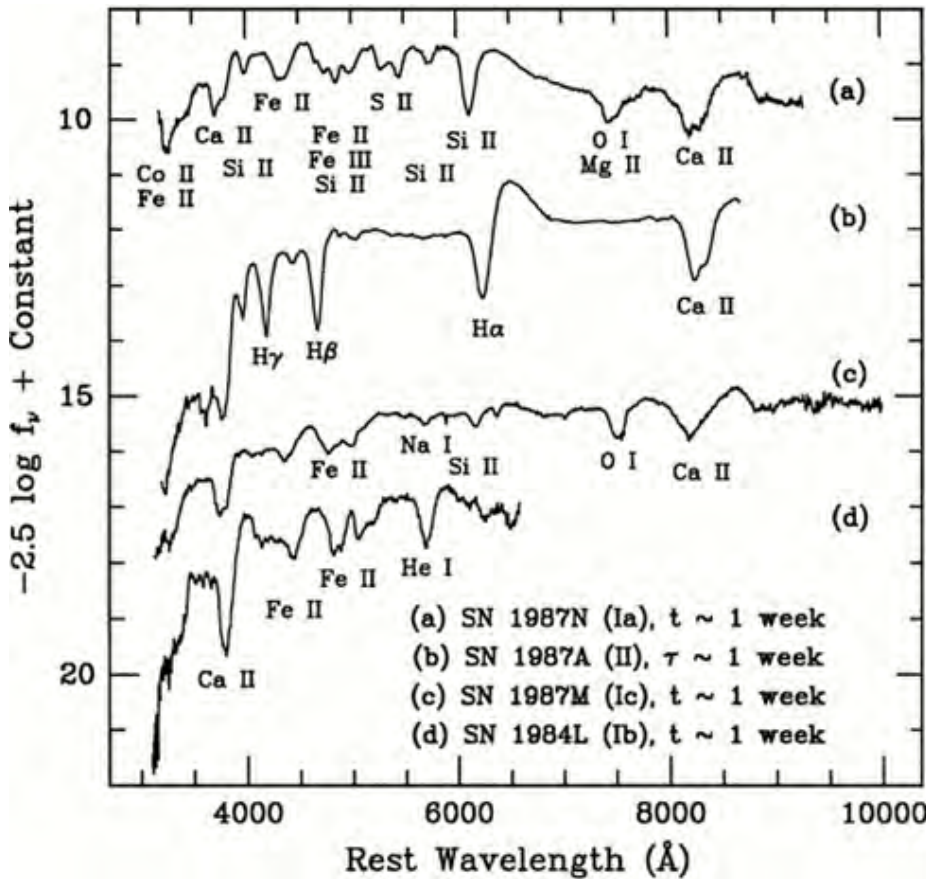
Type II supernova SN 2011dh was discovered on May 31, 2011 in M51. It was discovered by Tom Reiland, Thomas Griga, Amédée Riou and Stephane Lamotte Bailey. The discovery magnitude was 13.5 and it peaked at magnitude 12.1. The progenitor star was a highly luminous yellow supergiant with an initial mass of 18-24 solar masses.

Type Ib, Ic, and II come from the collapse of a massive star's core. This is the more classical description of a supernova. The inert iron-nickel inner core of the massive star exceeds the Chandrasekhar limit of about 1.4 times of the mass of the Sun. The core can no longer support its own weight, and collapses in just a few seconds. Without the inner core to support the rest of the star, the outer core starts to collapse inward toward the inner core. The inner core's collapse is finally stopped by neutron degeneracy.

The inner core now bounces back outward, initiating a shockwave that in the end disrupts the star in a Type II supernova explosion. The shock wave and extremely high temperatures exist long enough to create elements heavier than iron before the outer core and everything above it are blown into space. The remains of the inner core are either a neutron star or a black hole, depending on the mass of the progenitor star.

When a new supernova is discovered, we need to determine the type. We can slowly build up a light curve, which will tell us the type of supernova. We can also get a spectrogram to determine the supernova type more quickly. Not only does the spectrogram differentiate the types of supernovae, but we can use the spectrum to determine the age of the supernova. since the spectrum changes over time.

With multiple types of supernovae at various ages, the collection of spectrograms from previous supernovae to be compared to the new supernova can be quite large. For an astronomer to sit down



Supernova Spectra

This is a comparison of the spectra of various supernovae types. The top spectra is that of a Type I supernova, with a characteristic deep dip at 6150 Angstroms due to the presence of silicon in the expanding debris cloud. The second spectra is of a Type II with absorption lines from hydrogen, which are always absent from Type Ia supernova.

and compare the new spectrogram to the comparison library of old spectrograms can be quite time consuming.

To solve this problem, astronomers Stéphane Blondin and John L. Tonry studied the library of supernovae spectrograms to determine an algorithm (a step-by-step problem-solving procedure) to match a new supernova spectrogram to the existing library. This will allow astronomers to identify the type of

supernova and its age. They called the program they created from the algorithm SNID.

The algorithm had to identify the lines in the spectrum of the supernova. Then using the library of spectrograms, it then identifies the type of supernova by comparing the lines to the known lines from other supernovae. It not only identifies the standard types, but also checks the new supernova against the less common peculiar types of supernova. These peculiar supernovae have spectrums that do not fall into the usual types. These are usually identified as “similar to” a previous supernova.

Once the basic type is identified, SNID uses the position of the narrow lines in the spectrum to determine the redshift of the parent galaxy. This gives the astronomer the distance to the supernova and its parent galaxy, which can be important in establishing the absolute brightness of the supernova.

With all this information, the algorithm can now determine the age of the supernova. This is usually stated as so many days before or after maximum light. Studies using this algorithm show that Type Ia supernovae are very similar whether they are at high or low redshifts. This means that over the age of the universe, the absolute brightness of Type I supernovae are always the same, allowing them to be used as “standard candles”

Astronomers can plot the independently measured distance of Type I supernovae against their redshift. This calibrates the scale of the universe allowing us to use an object’s redshift to compute the distance to the object. However, this is not the last word in the size of the universe. It is possible that Type Ia supernovae actually represents two different groups of progenitors, astronomers are studying this possibility and the effect it would have on our understanding of the scale of the universe.

* * *

Polar Alignment: When, Why, and How

Alex Woronow, ASLC & Black Range Observatory

Installment 3: Polar Alignment: Computer Aided

The methods described in Installment 2 of this series all provide some degree of polar alignment while establishing the foundation for good-performance go-to capability. In fact, iterative drift alignment, for the very patient, can implement a high-quality polar alignment. Nonetheless, in this installment, we will discuss the more efficient computational-based methods specifically designed for polar alignment. One more thing: if you use a computer-assisted, computational-based method for polar alignment, disabling or resetting any star alignment data before starting would probably be wise. Anyway, once the mount's polar axis is adjusted, any pre-existing star alignment becomes moribund. Note that the two previous installments of this 3-part series are available on our Yahoo site in the folder Files/AlexW/PolarAlign.

Few publications describe the algorithms underlying polar alignment by computational methods; most remain proprietary and undisclosed. The majority of proprietary algorithms are implemented within the mount's computer or handbox. Those one or two disclosed methods have suspect assumptions and often ineffective results. For instance, one set of algorithms appeals to "approximating" spherical triangles with planar ones. That is, generously speaking, totally unjustified. The polar-alignment algorithm within the open-source *AstroTortilla* program does not produce reliable results, and few observers attempt to use it.

The computational approaches, proprietary and otherwise, generally ask the user to center a star in the eyepiece, sync the coordinate system of the mount to that location (make the mount's internal computer coordinates coincide with the star's coordinates), then move to one or more additional stars, record the miss-distance, and compute a polar-alignment correction. The program "*AlignMaster*" appears to be in this category of algorithms as does Celestron's *All-Star* routine. A second approach could use plate solutions to determine slew miss-distances and computes the polar-alignment from that information. Probably, little computational difference exists between these two methods. The results should be comparable, too.

One may wonder what the large professional observatories do. According to one professional astronomer I questioned on the matter a few years back, it goes roughly like this...

- Sync to a star
- Slew to another star and note the slew error
- Turn a screw to remove the slew error
- Slew to another star
- Realize you turned the screw the wrong direction, so turn it the other way
- Slew to another star and notice that again you appear to have turned the screw the wrong way so redo the original correction
- Repeat until alignment is achieved.

Perhaps his description was in jest...perhaps not. In any case, we can do better!

A Proposed Polar-Alignment Method: In this section I will describe a polar-alignment method that is both easy to understand and easy to implement. This method is much quicker than waiting for drift results, and is based on a solid mathematical foundation. I have developed this method on my own and have a first-cut programmed implementation (called "*AlignTamer*"), almost ready for β -testing. When it has been validated, it will be completely documented in the open literature and available for anyone

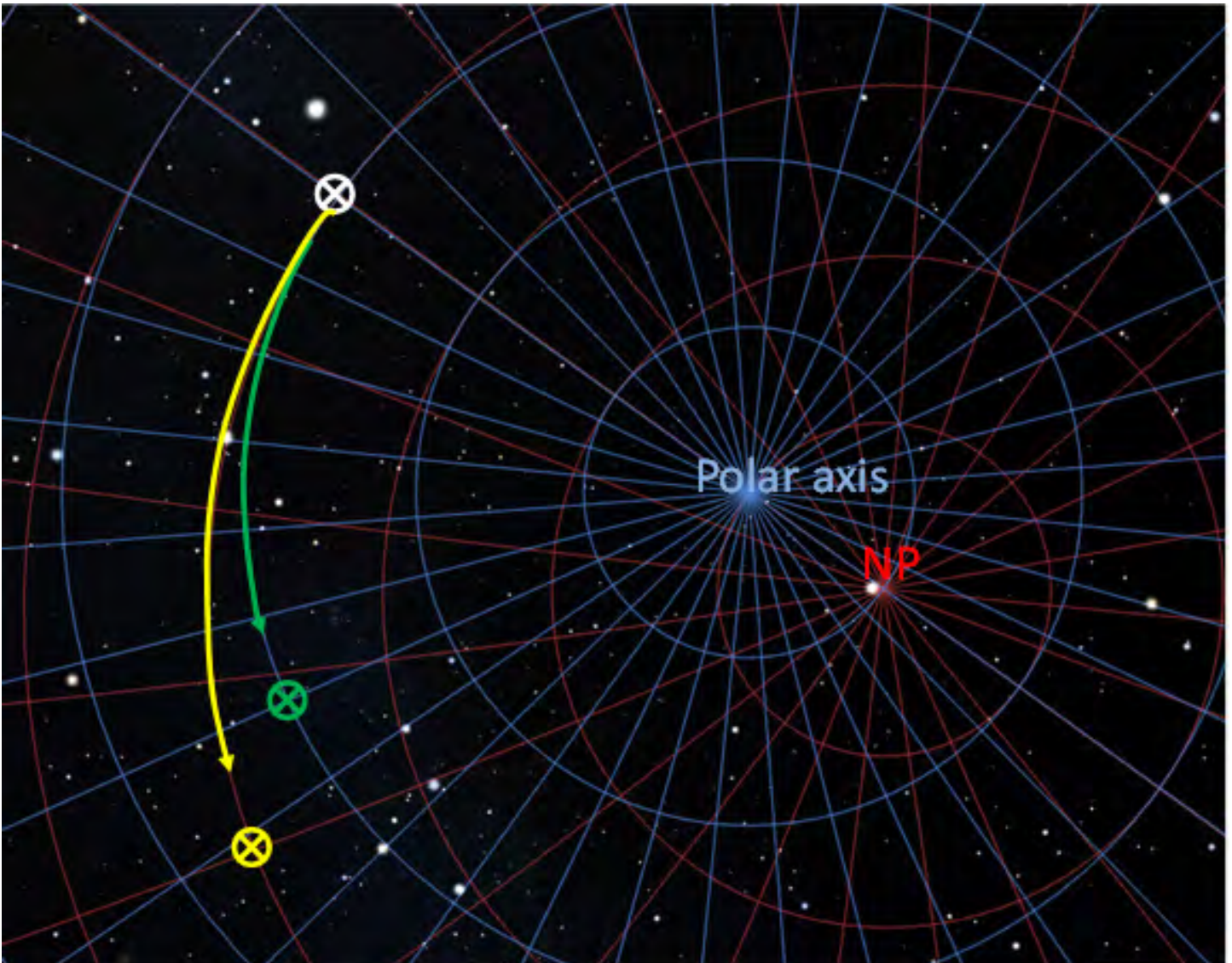


Figure 7: *The effect of having a misalignment between the true North Pole (NP) and a mount's polar axis is a displacement of the two coordinate systems. An object initially at the white circle follows a path (yellow) of constant declination around the North Pole to the location of the yellow circle, as the earth rotates. However the misaligned mount expects the object will follow the path indicated in the blue coordinates and follow the green path. Important! The RED grid shows 1hr = 15° increments in right ascension whereas the BLUE grid shows 10° increments. (Stellarium)*

to incorporate into their algorithms as freeware--no licensing required. What follows constitutes a first description of the method and it should, in fact, suffice for anyone with sufficient programming skills to implement it.

The algorithm needs the telescope sight's latitude and longitude and the time. Commonly, all three of these are now provided by GPS devices (or apps on smart phones). Although not specifically required by the method, suppose that the GPS devices communicate directly with the mount, as my version of the algorithm reads this information from the mount's ASCOM interface. We also need a specific plate-solving algorithm and an imaging camera. More about those later.

Again, we start from a state similar to the one depicted in Figure 7 (from Installment 2). The mount's polar axis deviates from true North, thereby displacing the actual coordinate system (red) from that presumed by the mount (blue). The alignment procedure proceeds as follows:

1. The mount is pointed to some arbitrary location (RA, Dec) in the sky and an exposure made of the star field (call it Image 1). In the case of Figure 7, the white circle represents a possible location for that exposure.

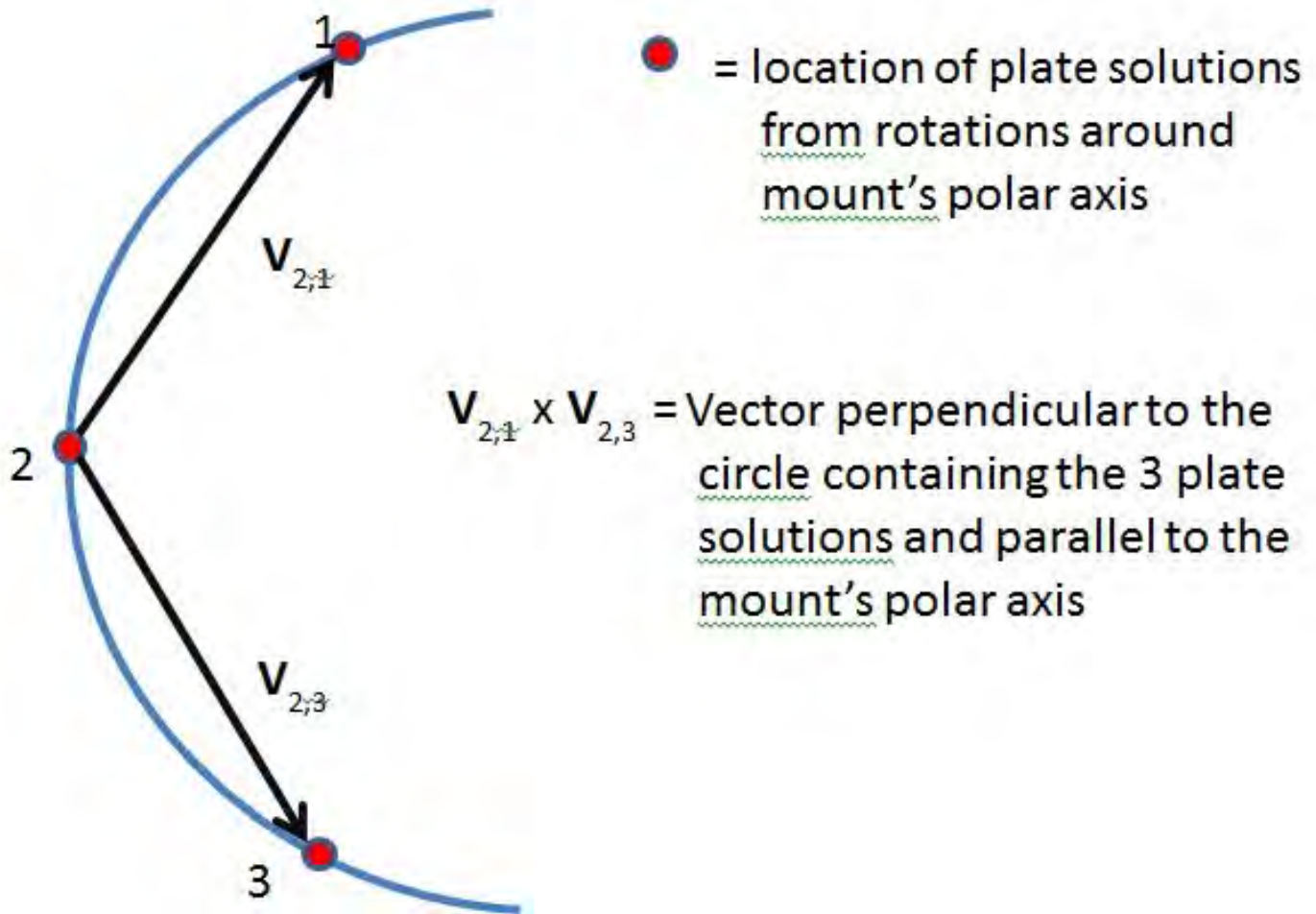


Figure 8: The blue arc corresponds to a portion of one of the blue declination grid lines in Figure 7. Such an arc would be traced if a misaligned mount moved around its polar axis only. The three red dots indicate imaging/plate-solution locations. The two vectors joining pairs of imaging locations on the circle lie in the plane of the circle and their cross product points to where the mount's polar axis also points. (See Figure 9.)

2. The mount is **slewed in right-ascension only**...the declination axis setting remains unchanged. The new star field is imaged (call it Image 2). Say in Figure 7 that exposure could occur about halfway between the white and green circles.
3. We repeat step 2 for a different value of the right ascension, again not altering the declination axis's setting and also keeping all three exposures on the same side of the mount. Call this image Image 3. In Figure 7, say that this exposure might occur at the green circle.
4. We plate solve all three images for their center coordinates. Those plate solutions give the true coordinates of the three exposures in the red grid, not the values along the blue grid of Figure 7.
5. We form two pairs of vectors from the three points, as shown in Figures 8 and 9.
6. Taking the vector cross-product of those two vectors generates a new vector that points to the same location in the sky where the mount's polar axis points (Figure 9). This, with some basic algebraic relationships among coordinate systems, yields the altitude and azimuth pointing errors.
7. We center some reference star then click a program button, and the mount slews off that star such that adjusting the mount's polar axis altitude and azimuth (and no other axes) to recenter the star shifts the mount's polar axis to align with the direction of true North.

And, we are done! Well, maybe. This is an untested algorithm and refinements probably need to be made. Most likely, one iteration will be both beneficial and reassuring, but that extra step is not too onerous because a single pass at alignment should take on the order of 10 minutes or less including imaging time. Also, at this point we do not know if some range of imaging declinations produces better

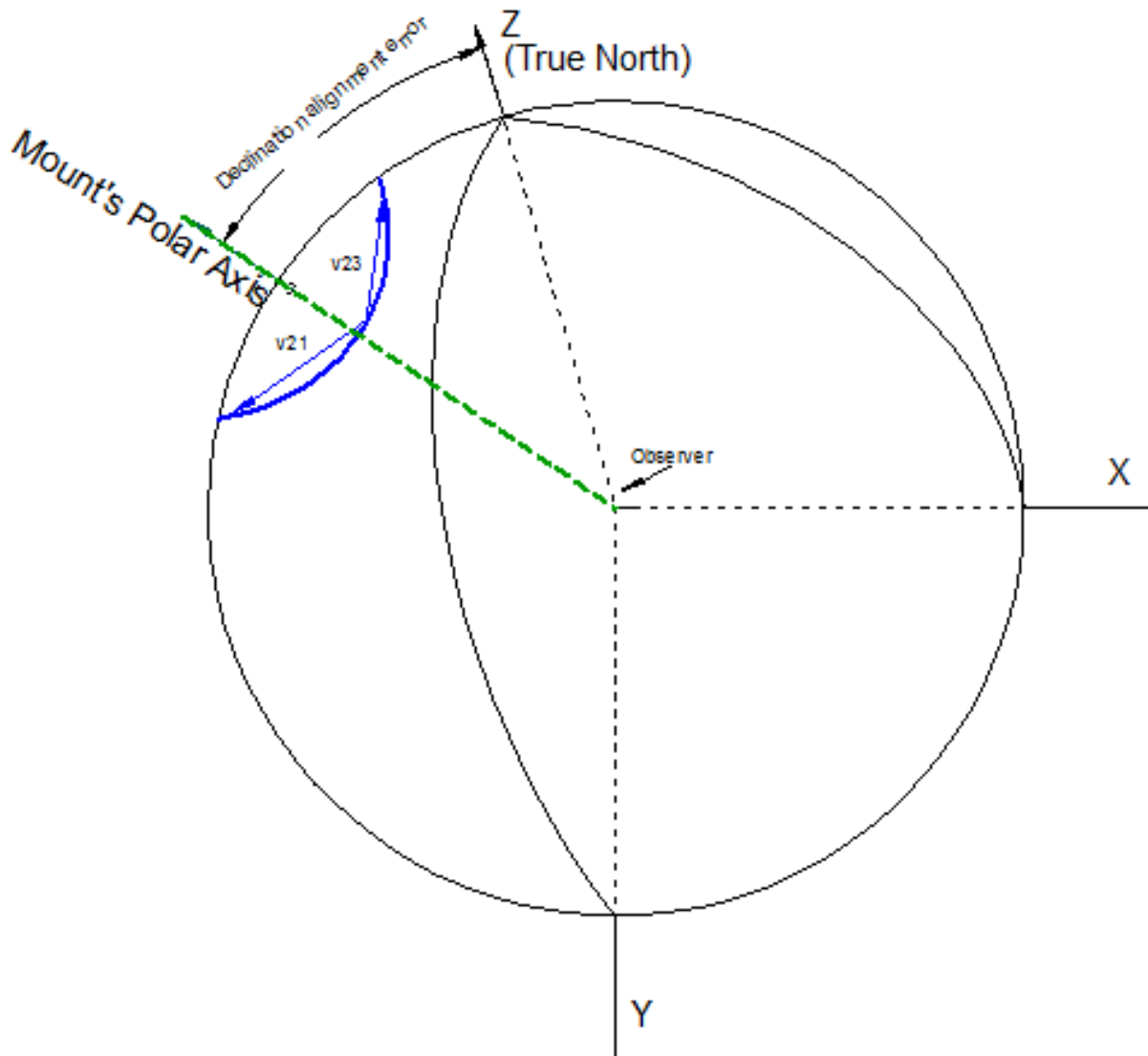


Figure 9: The cross product of the two vectors $V_{2,1}$ and $V_{2,3}$ (see Figure 8) points perpendicular to the plane containing the blue circle. That cross-product vector, when translated to the center of the celestial sphere, passes through the sphere along the same direction as the mount's misaligned polar axis. The green arrow indicates that direction.

results than others, but on the plus side, this algorithm can be carried out at imaging elevations away from the effects of atmospheric refraction and away from any obstructions that may thwart the methods requiring specified alignment stars.

If one adjusts for periodic error after a successful polar alignment with a well designed and manufactured mount, then unguided exposures of 5' to 15' should be possible even with optical systems having intermediate focal lengths. Not too much information exists to tell us if this is often achieved by commercial systems, in practice, although I am familiar with reports for ASA mounts claiming that 15' unguided exposures are not too taxing and that iTelescope does not implement active guiding on some of their top-end PlaneWave mounts.

Finally, a quality polar alignment does not automatically lead to accurate go-to capability. Subsequent to polar alignment, one may also execute a star-alignment or pointing-model procedure. Before over-working the go-to issue, consider this: many modern imaging programs take pre-exposures, plate-solve them, and then center the target for imaging, thereby compensating for any go-to deficiencies.

Frustration Remains: Maybe this should be a note to telescope mount designers and manufacturers, but the adjustment of a mount's polar axis, in elevation (altitude) and azimuth, suffers from design inadequacies that frustrate accurate alignment, or at least make it a struggle. The principal difficulties arise from the adjustments that are too coarse and imprecise and, when finalizing an adjustment, simply tightening the locks causes excursion of the polar axis away from its intended direction. In the end, these appear to be the limiting factors to accurate polar alignments in many mounts of modest cost.

Enter *PoleMaster*: qhyccd has released a camera that attaches to the declination axis of a mount and, like a polar-alignment scope, looks northward. They call this QHY5L-II based system *PoleMaster*—basically, an ersatz implementation of the method proposed above. But, still, it offers good potential accuracy and ease of implementation. It may be of special interest to imagers who also require portable rigs.

Basically, its approach is closely parallel to the *AlignTamer* method described above: Three sky sightings are made at or near 90° declination and the pointing direction of the mount's polar axis is determined. The obvious limitation is that the polar region must be clearly visible. Functionally, the three sightings consist of three successive images. On those images (displayed on a computer screen), the user identifies Polaris and a circumpolar star pattern. After the three manual identifications, the underlying program calculates the location of the true North Pole and the polar-axis pointing. The program then displaces the image in a manner that when an overlay again matches the star pattern (though altitude and azimuth mount adjustments) the mount becomes reasonably aligned; qhyccd (<http://www.qhyccd.com/PoleMaster.html>) claims an accuracy within 30 arc seconds, based on the fact that 30 arc seconds is the size of a single pixel. The Nyquist-Shannon sampling theorem suggests that maximum accuracy would be 2x-3x that value, assuming that you are physically and visually able to align the template over the star field to pixel-level accuracy and then able to tighten mount adjustments without inducing polar-axis excursions of more than a pixels or so. My experience with this device is that it is relative easy to use, despite the mangled English in the instructions, and can provide moderately reliable polar alignments—reliable enough to suppress noticeable image rotation for 10+ minute exposure with a 800mm focal-length scope.

Nonetheless, considering the above stipulations plus the significant constraint of requiring visual access to the polar region, the *PoleMaster* is, at best, a problematic, \$270, one-trick pony.

Before we conclude, how about a little quiz on interpreting causes of some imaging defects when attempting to image DSO and you have good focus?

Assume you are imaging with tracking enabled, but no guiding.

1. If all stars show trails, then_____ (Ans: you have either tracking or alignment problems, or both.)

Assume you are imaging with tracking **and** guiding enabled.

2. If all stars show trails, including the guide star, then_____ (Ans: if you haven't misaligned your mount by 10s of degrees, then you have tracking problems, and there are many possible candidates: Poor choices for tracking aggressiveness or correction speed, inadequate focal length of the guide scope, binding/dragging cables, loose connectors, unbalanced loads, excessive backlash, mount insufficient for payload, sagging or shifting OTA, intermittent clouds, guide star too faint or too near to the edge of the guider FOV, wind,)

3. If the guide star is round, but the other stars show trails, then_____ (Ans: you have polar-alignment problems.)

4. If all stars look bloated, then_____ (Ans: you probably have poor focus, dew on your optics, or seeing stinks.)

5. If all stars are round and small, then_____ (Ans: you are HAPPY.)

This concludes my survey series on polar alignment of an equatorial mount. Much more could have been said, but, hopefully, both beginners and more advanced observers have had some Eureka moment. If you have questions, comments, or discussions, our Yahoo site would be a good place to enter them. But I also would be happy to respond via my email (alex@awkml.com).

If you have a desire to collaborate on the testing or programming of the proposed method for polar alignment, I most certainly want to hear about it!

Alex

Photo of the Month



M42 with "Ghost" Nebula

Great Nebula in Orion and surrounding 1 degree field of view. The well known diffuse nebula has both emission and reflection components. The red hue is a result of the H α recombination line radiation at a wavelength of 656.3 nm. The blue-violet coloration is the reflected radiation from the massive O-class stars at the core of the nebula. The "dark" or "ghost nebula" is interstellar dust which permeates throughout this giant molecular gas cloud .

It is the closest region of massive star formation to Earth at 1350 light years.

Capture info:

Canon EOS 60D

3 hours total integration time, 90 sec subs

WO GT 102 refractor

Paramount ME

Pixinsight processing

Feb 2016

Las Cruces NM

by Dave Doctor

Photo of the Month



OBJECT: M 37 An Open Cluster in Auriga. Distance: 4600 light years

This was done from my back yard with my Canon 60Da camera attached to an 8" f/4 Newtonian reflector on a Celestron CGE mount. 97 31-second images were combined and initially processed in Images Plus, then a background gradient was removed in Photoshop, yielding this image.

Autoguiding was with PHDGuide, a Meade DSI-Pro-I camera and an Orion f/7.5 80ED refractor. I was surprised to note what appears to be one deep red star, perhaps a carbon star, near the top center of the picture, though I'm sure it was a surprise only to me, since it's been there for billions of years.

Copyright: Chuck Sterling

Yuk of the Month

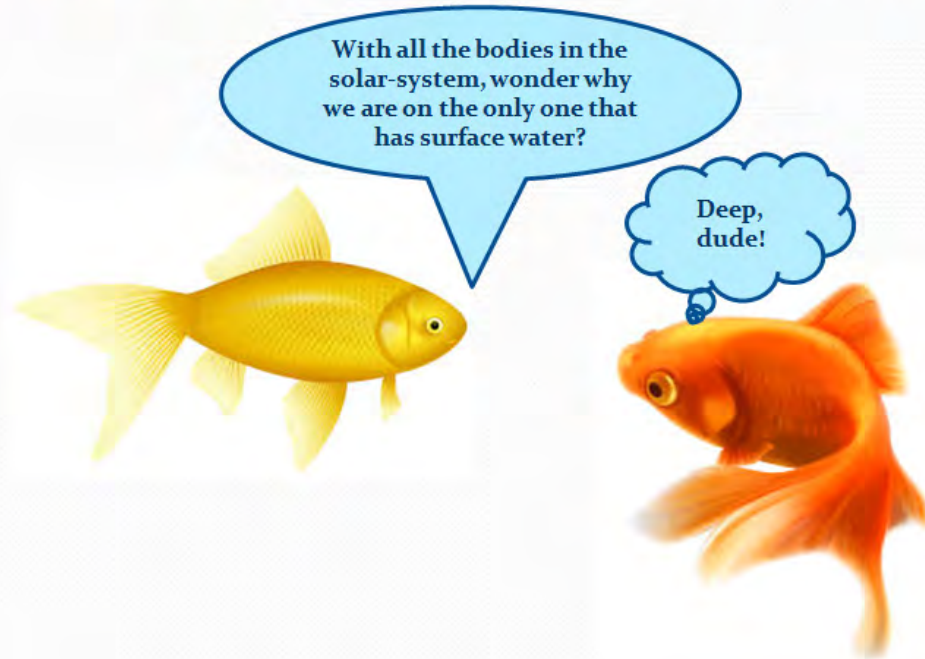
This is a new idea for the HDO. It is an attempt at humor, some might say feeble. However, the goal is to bring a smile to the faces of our readers, not to win any contests.

We will provide Yuks as they become available. If you have any cartoons, jokes, stories, etc, please submit them. Esoteric or corny are just fine, as long as somebody smiles!



If you do not know what a SNID is, check out Bert Stevens article in Back at The Telescope for an explanation.

THE ICTHROPIC PRINCIPLE



Submitted by Alex Woronow